THE
NATIONAL PHYSIQUE

A. STAYT DUTTON

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PREFACE

In bringing forward this subject, a few remarks seem to be called for in reference to the matter discussed.

On going into the various questions regarding the national physique, as they concern many of the branches of medicine and some of the allied sciences, I have thought it best in certain instances to quote the words of those who have made individual subjects their especial study, and the views thus stated are, in most cases, generally accepted with regard to the matter under consideration.

While acknowledging my indebtedness to the works of different authors, many of which are referred to throughout the text, I must also acknowledge the aid I have received from the 'Minutes of Evidence' and from the 'Report of the Committee on Physical Deterioration,' which, as well as containing the statements of investigators who are in a position to form a valuable opinion on the subjects considered, have directed attention to those that seem more particularly to need inquiring into.

In endeavouring to elucidate the questions contained in this work, views have been taken with respect to certain points, which in some cases are similar to, and in some instances differ from, those of others; but these opinions, whether personally held or otherwise, have been of much assistance, and have largely enabled this attempt to be made to contribute to the advancement of the science and of the practical value of medicine.

5, Divinity Road,
Oxford.
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INTRODUCTION

On closely observing the inhabitants in the cities, towns, and villages of England, with the object of investigating the state of their physique, one's notice is attracted by the large number of those of both sexes and of all ages who are affected with various degrees of anæmia.

During the last fifteen years I have been engaged in practice in fifty different districts, forty-eight of which were in England—including twelve in London—and two in Wales, for periods varying from a year and a half to six months, three months, one month, or a week or two.

Both from observations during this practice, and of the inhabitants in many other places and under many different circumstances, I some few years ago came to the conclusion that such conditions must be anything but favourable to the robust development of the population of the country as a whole; and when the question of physical deterioration was brought forward, I formed the opinion that the main cause of such degeneration as might be present was due to the blood of individuals being defective in quality.

With the object of ascertaining that the conclusion arrived at was scientifically correct, I made arrangements to take such opportunity as could be obtained in the course of a year for testing the blood in as many persons as possible in town and country districts.

After a course of laboratory work in the clinical examination of the blood, at the end of the year 1903 I was prepared to commence the inquiry, and during the year 1904 and the first three months of 1905 I was able to make tests in a number of individuals in the North, South, East, West, and Midlands of England, and the results of them verified the observations previously made.

The question of whether the physique of the population is declining, and if so, in what degree, is one that admits of different views, but the consensus of opinion of numerous observers appears to be that there is a deterioration.

From personal investigations, I believe it to be going on, and that only by adopting certain medicinal and other measures can the blood of the individual be maintained in a sound condition, and with this the health of the body as a whole.

THE NATIONAL PHYSIQUE

CHAPTER I.

HEALTH AND ITS MAINTENANCE.

HUMAN physiology may be described as the science which concerns the living body in health.

While studying the subject, it becomes increasingly evident that a normal condition of the blood is the main essential, both for the health of the body as a whole, and of the various structures contained in it.

Each organ and tissue is dependent for its nutrition, through the medium of the lymph, on the supply of sound blood, which is to them, as Sir M. Foster says, 'their immediate air and food.'[1]

The brain, the internal organs, the digestive tract, the bones, muscles, and skin, are sustained in a healthy state by this nutrient fluid, and although the nervous system has a controlling influence over the various physiological processes of the body, yet it equally relies on the nutrition derived from the blood.

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[1] 'Textbook of Physiology,' part i., sixth edition, p. 14.

The most vital necessities for the maintenance of health are food, water, and oxygen, and as the blood is directly interested in the conveyance of nutrient material and water from the alimentary canal to the various tissues, so also is it expressly concerned in the absorption of oxygen in the lungs and its distribution to them.

In addition to important functions in relation to nutrition and respiration, it is intimately associated with secretion, excretion, and, as the carrier of the necessary material, in the production of heat and energy.

The blood is a red fluid, slightly alkaline, and having an average specific gravity of 1055, and in the human body is about one-thirteenth of the total body-weight.

It is composed of a nearly colourless liquid called the plasma, in which are suspended the corpuscles. The majority are coloured, there being five to six hundred times more red than white. The colour of blood is due to the presence of the red corpuscles. In 100 parts by weight of blood, about 40 parts are composed of corpuscles and 60 parts of plasma.

The composition and functions of the blood will not be gone into at any length, but physiology shows that while the red corpuscles are the oxygen-carriers, the plasma contains the nutriment derived from food.

The plasma consists of water and solids, the latter in the proportion of about 10 per cent., of which 8 are proteid in character. The remainder of the solids are composed of extractives, fats and sugar, salts and water, and thus the plasma includes in its composition that material derived from food which is necessary for the nutrition of the tissues. It also contains small quantities of the gases, oxygen, carbonic acid, and nitrogen.

Certain parts of the plasma which transude from the arterial capillaries form the lymph, and on making a comparison between the composition of these fluids, it is seen that, broadly speaking, as Sir M. Foster observes, the latter contains all the constituents that are present in the former, but a smaller proportion of proteids.[1]

The red corpuscles are composed of an elastic and transparent stroma uniformly pervaded by the colouring matter called hæmoglobin. On studying their chemical composition, hæmoglobin is seen to be by far the most important constituent, and comprises about 90 per cent. of the dry organic matter.

They undergo constant wear and tear, and while fresh corpuscles enter the blood, others are being destroyed. It is considered that they are formed from cells contained in the red marrow of bones and in the spleen, and that their disintegration also occurs in the latter organ and in the liver.

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[1] 'Textbook of Physiology,' part ii., sixth edition, p. 524.

That the coloured corpuscles would not compose so large a proportion of the blood unless they had important functions is evident, and being the oxygen-carriers, they are concerned in one of the most essential of the physiological processes in the body.

It has been proved that the oxygen present in the blood does not follow the law of absorption according to pressure, but that it is associated with the hæmoglobin; and the result of experiments shows that only a very small quantity can be obtained from serum, which, Sir M. Foster says, 'does not amount to half a volume in 100 volumes of the entire blood to which the serum belonged.'[1]

With the exception of this small amount of oxygen contained in serum, and in the plasma of blood as it circulates in the living body, all the rest of the oxygen absorbed during the respiratory process is loosely combined with hæmoglobin, this combination being known as oxy-hæmoglobin.

This fact is of great importance, as although the absorption of oxygen is not entirely independent of the degree of its partial pressure in the atmosphere, unless the blood contains the proper percentage of hæmoglobin it is incapable of absorbing the normal quantity of oxygen. Hæmoglobin can absorb a definite amount, and Sir M. Foster states that 1 gramme absorbs 1·59 c.cm. of oxygen.

If, therefore, hæmoglobin is deficient by 20 or 25 per cent. in its normal proportion in the blood, the quantity of oxygen that the latter is able to absorb in the twenty-four hours will be 20 or 25 per cent. less than should be the case. So it is in whatever degree the hæmoglobin is reduced, by that percentage will the amount of oxygen the blood is capable of absorbing in twenty-four hours be deficient.

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[1] 'Textbook of Physiology,' part ii., sixth edition, p. 588.

The Importance of Oxygen.

NUTRITION.—Oxygen is a necessity for the life and nutrition of the tissues. Sir M. Foster remarks: 'Oxygen, it is true, is necessary for the life of the muscle: when venous instead of arterial blood is sent through the bloodvessels of a muscle, the irritability speedily disappears, and unless fresh oxygen be administered the muscle soon dies.'[1] 'We may profitably take the nutrition of muscle as exemplifying, in the midst of features special to muscle, the general plan of vital metabolism. The muscle in a normal state of things lives ultimately on the proteids, fats, carbohydrates, salts and water of the food, and on the oxygen of the inspired air, but lives directly on the blood which brings these things to it.'[2]

Dr. Starling says: 'On the processes of metabolism

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[1] 'Textbook of Physiology,' part ii., sixth edition, p. 610.
[2] *Ibid.*, p. 862.

—the decomposition and oxidation of food-stuffs—depends the maintenance of life.'[1]

Oxygen is also a necessity in the production of heat and energy.

HEAT.—Sir M. Foster writes: 'The heat of the body is generated by the chemical changes, which we may speak of generally as those of oxidation, undergone not by any particular substances, but by the tissues at large.'[2]

Dr. Halliburton observes: 'The great source of heat is, as already stated, chemical action, especially oxidation. Any given oxidation will always produce the same amount of heat. Thus, if we oxidize a gramme of carbon, a known amount of heat is produced, whether the element be free or in a chemical compound.'[3]

Metabolism and the production of heat are going on in all the tissues, but some are greater heat-producers than others. The muscular system is the greatest source of heat; the secreting glands and especially the liver generate it to a considerable extent; the brain also is a source. The amount evolved in bone and in other tissues is small in comparison to that produced in the muscles and secreting glands.

ENERGY.—Sir M. Foster says: 'Neglecting all subsidiary and unimportant sources of energy, we may say that the income of animal energy consists in the oxidation of food into its waste products, viz. the oxidation of proteids, fats, and carbohydrates into urea, carbonic acid, and water.'[1] 'There are two ways only in which energy is set free from the body: mechanical labour and heat.'[2]

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[1] 'Elements of Human Physiology,' eighth edition, p. 500.

[2] 'Textbook of Physiology,' part ii., sixth edition, p. 844.

[3] 'Handbook of Physiology,' sixth edition, p. 599.

He also adds, a trustworthy method of estimation shows that 'Between one-fifth and one-sixth of the total income is expended as mechanical labour, the remaining four-fifths or five-sixths leaving the body in the form of heat.'[3]

Not only is there expenditure of energy in all kinds of muscular work, exercise, and in locomotion, but also in the mental effort, in the manifestation of nerve force, in the movements of the respiratory muscles, of internal organs as the heart—and in the various physiological processes—as secretion, nutrition, and growth.

The physiological importance of oxygen for the life and nutrition of the tissues is thus seen. Food and oxygen are the main necessities for the maintenance of health, but although the food may be good and of suitable material, unless the blood can absorb the normal quantity of oxygen, the nutrition of the individual will be defective, and the oxidation which goes to keep up the heat and energy of the body deficient.

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[1] 'Textbook of Physiology,' part ii., sixth edition, p. 837.

[2] *Ibid.*, p. 840.

[3] *Ibid.*, p. 842.

Oxygen Needed Daily.

Kirke says that 13,000 grains may be taken as a fair average of the amount of oxygen that is absorbed daily by the lungs in a healthy adult.[1] If, then, hæmoglobin is deficient in the blood to the extent of one-tenth, one-fifth, one-half, or more, the oxygen which the blood is capable of absorbing during twenty-four hours will be reduced from 13,000 grains to 11,700, 10,400, 6,500 grains, or less, and so a deficient supply will be daily available for nutrition and for the production of heat and energy.

SECRETION.—The submaxillary salivary gland and the mammary gland may be taken to illustrate the functions of the blood in secretion. All the tissues of these glands are dependent for their normal growth and development on the nutrition derived from the blood, and the epithelial cells lining the alveoli, whose function it is to secrete and form the saliva and the milk, are equally dependent on this nutriment for their capability to normally fulfil this purpose. From the blood also comes the material which is necessary for the formation of the secretion. The submaxillary may be taken as typical of secreting glands, and in the case of the mammary gland the secretion only differs in that part of the secreting cells go to form part of the milk.

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[1] 'Handbook of Physiology,' eleventh edition, p. 535.

Sir M. Foster observes: 'The blood is the ultimate source of milk, but it becomes milk only through the activity of the cell, and that activity consists largely in a metabolic manufacture by the cell and in the cell of the common things brought by the blood into the special things present in the milk.'[1]

Unless, then, the blood is sound, the nutrition of the tissues and epithelial cells of the secreting glands of the body will be defective, and the cells incapable of satisfactorily fulfilling their functions, of secreting and forming those secretions of normal consistency which are necessary for the maintenance of health.

Health.

The question now arises, What is health?

To have a clear conception of what such a condition is, and to have a standard to go by, is of importance to each individual, and to those who are directly concerned in the health and the maintenance of it in the community at large.

Sir W. S. Savory wrote: 'But although Life and Health are among our most familiar words, and in their ordinary meaning none are more widely understood, yet in their scientific sense no terms are more difficult to comprehend.'[2]

These words, which express a general view, show that there is need of a clearer estimation of health.

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[1] 'Textbook of Physiology,' part ii., sixth edition, p. 821.

[2] Malcolm Morris, 'The Book of Health,' 1883. p. 1.

How life is produced in the cell is not capable of being shown on any physiological basis, but a physiological standard of health can, I think, be fixed, and this would be the definition.

Health is that condition in an individual of normally constructed body and sound mind in whom no disease exists, and who has normal blood.

Taking this as the definition of health, it is possible to ascertain by clinical methods the absence of disease, and also by clinical examination to ascertain the capacity of the blood.

With a sound mind and a sound body, and the blood in a normal condition, it can be said of such an individual that he or she is in health.

A normal condition is, physiologically, a perfect state of the blood, and however difficult it may be to reach absolute perfection, this may be said—that approximation to normal is not attained while such a vital constituent of the blood as hæmoglobin is deficient in quantity. The importance of the oxygen-carrying constituent to the individual's health is clearly shown by the result of treatment with iron; for, in anæmia, at the same time that the hæmoglobin is renewed the nutrition of the tissues improves, and with its restoration to the proper percentage in the blood, the whole appearance becomes that of health, and the normal vitality and energy of the body are regained.

For health, then, and its maintenance, an efficient blood-supply is of the first importance. The earlier age at which it is normal, the better for the growth and development of the tissues and the greater probability that the individual on reaching maturity will be sound both mentally and physically.

CHAPTER II.

ANÆMIA.

This is one of the diseases of the blood which presents characteristics according to the degree and nature of the anæmia present.

In some instances there is no defect in the number of red corpuscles, but a deficient amount of hæmoglobin; in other instances there is a reduction both in the number of red corpuscles and also in the hæmoglobin.

Dr. Cabot remarks: 'In all anæmias the individual corpuscles suffer in quality first, and only after some time begin to decline in number. This is especially the case in chlorosis, although by no means peculiar to that disease. In the restoration of the blood, 'first the corpuscles gain in numbers, the hæmoglobin still remaining low; later, and much more slowly, the colouring matter, size, and weight of the cells are renewed.' These 'blood changes are just the reverse of those seen during the development of the disease.'[1]

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[1] 'Clinical Examination of the Blood,' fifth edition, pp. 149, 153

With regard to the restoration of the blood after hæmorrhage, Dr. Osler observes: 'The watery and saline constituents of the blood are readily restored by absorption from the gastro-intestinal tract. The albuminous elements are quickly renewed, but it may take weeks or months for the corpuscles to reach the normal standard. The hæmoglobin is restored more slowly than the corpuscles.' 'The reduction in hæmoglobin is always proportionately greater than in the corpuscles.'[1]

Drs. Fagge and Pye-Smith say: 'The most constant character of the blood in anæmia is deficiency in hæmoglobin.'[2]

In those anæmic conditions where the reduction in hæmoglobin is such that, while not occasioning anæmia to an extent sufficient to incapacitate individuals from following their usual occupations, yet is of a degree sufficient to prevent the normal growth and development of the body, there is frequently no decrease in the number of red corpuscles, the unsatisfactory health not being due to a deficient number, but to their defective quality. In such cases not only is growth and development impaired, but, owing to the lowered vitality of the tissues, the individual is predisposed to the attack of many diseases.

The hæmoglobinometer is the instrument with which a scientifically accurate estimation of the quantity of hæmoglobin can be made. When it is required to enumerate the red corpuscles, the hæmacytometer may be used, by means of which the number that are present in a cubic millimetre of blood can be counted.

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[1] 'The Principles and Practice of Medicine,' sixth edition, p. 719.

[2] 'A Textbook of Medicine,' fourth edition, vol. ii., p. 755.

In secondary anæmia, the estimation of hæmoglobin by the hæmoglobinometer is the clinical diagnostic method of greatest value, for, as seen, the colouring matter may be reduced considerably below the normal physiological proportion before there is any decline in the number of red corpuscles, and also in the renewal of the blood medicinally the amount of corpuscles becomes normal some time before the hæmoglobin is restored. In pernicious anæmia the cells are reduced in number proportionately to a greater degree than is the hæmoglobin, and when this is suspected, the counting of the corpuscles and their microscopical appearance becomes of more importance. In those diseases also in which the white corpuscles are increased in the blood, the hæmacytometer is necessary for their enumeration.

Gower's hæmoglobinometer is the one now described. Of the two cylinders of the instrument, one contains glycerine jelly coloured with a mixture of carmine and picrocarmine, so that its tint is that of 20 cubic millimetres of normal blood diluted with distilled water up to 2 c.c.—that is, in the proportion of 1 in 100. The other cylinder, of exactly the same size, is graduated so that a space equal to 2 c.c. has 100 divisions.

Of the blood to be tested, 20 cubic millimetres is taken up by a capillary pipette and placed in a little distilled water put into the graduated tube, and then further diluted with distilled water, which dissolves out the hæmoglobin, until the solution of fresh blood corresponds to the prepared standard. The degree of dilution at which the contents of the two cylinders are alike in tint indicates the percentage proportion of hæmoglobin in the blood. Blood containing red corpuscles normal both as to their quality and quantity will show, as estimated by the hæmoglobinometer, a normal percentage of hæmoglobin—that is, 100 per cent.—and any less degree will disclose by how much the physiologically normal quantity is deficient.

Anæmia has been said by some observers to begin at a hæmoglobin percentage of 80. That anæmic symptoms apart from the state of the blood—as headaches, pallor, and dyspepsia—then become more in evidence is to some extent no doubt the reason for considering it commences at this percentage. However, it may be said that anæmia begins at 80 per cent.; the condition of the blood and of the system as a whole are far from physiologically normal. The former is defective by 20 per cent. in hæmoglobin, and in consequence the oxygen-carrying capacity is reduced in the same proportion, the vitality of the body is thus considerably lessened, and such individuals neither have the appearance of health, nor are they of sound or robust physique.

The question then arises, What is the percentage of hæmoglobin, and the number of red corpuscles that should normally be present in the blood ?

This may be gone into in relation to men, women, and children.

In men the number of red corpuscles that should be found in the blood is 5,000,000 to the cubic millimetre, and the percentage of hæmoglobin 100. In some men of vigorous and robust constitution the coloured cells exceed this quantity, and there is a corresponding rise in the hæmoglobin. Those in sound health should have a percentage of 100, and with the men of the country having blood containing that quantity of hæmoglobin, although in the more robust it is exceeded, there would be a healthy and vigorous male population. Observations and blood-tests confirm this, and also that the blood of many of them fails to contain this amount.

In women the number of red corpuscles that should be present in the blood is considered by different observers to be less than in men, and 4,500,000 to the cubic millimetre is usually given as normal.

Kirke says they are 'rather fewer in women.'[1]

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[1] 'Handbook of Physiology,' eleventh edition, p. 102.

The percentage of hæmoglobin that should be found in the blood of women has not been fixed at a definite degree, as in the case of men, and different observers have said that various percentages are normal. The reason which is given for this decision is that the examination of the blood of women in their usual health shows that the hæmoglobin percentage varies, and on this account it has been said that a percentage of 75 upwards may be considered normal.

Taking such a number as fifty women, while some might have a hæmoglobin percentage above 90, and others a percentage of various degrees down to 75, this would not show that the latter can be normal.

If 4,500,000 is the proper quantity of red corpuscles per cubic millimetre, the corresponding physiological percentage of hæmoglobin is 90, and any less percentage is below normal.

The method I have adopted in order to arrive at the percentage of hæmoglobin which the blood of women should normally contain is to test that of those who have the appearance of health, are well developed, and free from any disease, and in such it is invariably above 90, and a percentage of 94 to 96 is that found in those in sound health.

This, then, is the percentage of hæmoglobin that should normally be present in the blood of women, and the corresponding number of red corpuscles is 4,700,000 to 4,800,000 per cubic millimetre.

Another reason which has been given for suggesting women may normally have a considerably lower hæmoglobin percentage than men is that menstruation causes an anæmic condition. The menstrual function makes a monthly demand on the constitution of the female, but when the blood is normal it induces only slight temporary anæmia, which is soon recovered from.

However different in the formation of the body and in muscular development the well-developed male may be from the normally developed female, the percentage of hæmoglobin in the blood of those of either sex in sound health differs only in a few degrees.

In children the hæmoglobin percentage has been noticed to be variable, and no definite percentage has been fixed as that which should normally be present. From the estimation of hæmoglobin in a number of children of both sexes, I have found that the percentage in the great majority is below 90, but it should be of this degree or above, in order that the blood may have the oxygen-carrying capacity necessary to ensure their normal vigour, development, and healthy appearance.

In boys from the age of seven to fourteen years who are in good health and well developed the hæmoglobin percentage is from 94 to 96.

In girls of the same age who are in health the percentage is from 90 to 94.

In children below the age of seven years it should reach to 90.

The number of red corpuscles that the blood of children should normally contain is 4,500,000 to 4,800,000 per cubic millimetre.

Blood weighs about $\frac{1}{13}$ part of the total body weight. This physiological fact shows that, although the percentage of hæmoglobin which should normally be present is 90 or above in those of both sexes and of all ages, yet the amount of blood and, consequently, of hæmoglobin in the body varies in proportion to the weight of those who are in sound health.

Anæmia is divided into two classes, primary and secondary. The primary anæmias are chlorosis and pernicious anæmia. The latter will not be described.

CHLOROSIS is that form of anæmia which comes on in girls from fourteen to seventeen years of age, sometimes later, and Dr. Osler has noticed it more frequently among blondes than in brunettes. The hæmoglobin in this form of anæmia is reduced to a greater extent than are the corpuscles, and so disproportionate are they that the blood is characteristic in this respect. Dr. Osler says: 'In sixty-three consecutive cases examined at my clinic by Thayer, the average number per cubic millimetre of the red blood corpuscles was 4,096,544, or over 80 per cent., whereas the percentage of hæmoglobin for the total number was 42·3 per cent.'

'No other form of anæmia presents this feature, at least with the same constancy and in the same degree.'[1]

The fact that the red cells are comparatively slightly reduced in number shows that the anæmic condition of the blood in chlorosis is mainly due to the deficiency in hæmoglobin.

As to the cause of chlorosis, the following is sufficient to account for it: It gradually comes on in girls who, in their younger days, before the time when the menstrual function should be established, have not had healthy blood. They have been living from seven to fourteen years of age or from an earlier period with blood deficient in hæmoglobin, the percentage being low—at 75 or less; and investigations show that there are many female children with this low percentage. At the time of puberty there is a demand on the system owing to the establishment of the menstrual function; this extra demand it is unable to supply, owing to their having lived for years with blood which was defective in quality, in consequence of which nutrition in the tissues has been deficient, and the vitality of the whole system low. The blood-forming organs are affected by the malnutrition, and are unable to supply red corpuscles in sufficient number or of good quality. The usual destruction of corpuscles goes on, and their quality continues to decrease, and this at a time in life when the body especially needs a supply of sound blood for the more active growth and development which then occurs. Treatment is delayed, and eventually all the symptoms of chlorosis make their appearance, and the blood is found to be deficient in hæmoglobin in various degrees.

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[1] 'The Principles and Practice of Medicine,' sixth edition, p. 722.

SYMPTOMS.—A full account of the symptoms of anæmia and chlorosis will not be given here, as it is found in all medical works, and the remarks are chiefly referable to chlorosis, although, of course, most of the symptoms are similar to those which occur in secondary anæmia.

The skin, the lips, the mucous membranes of the mouth, tongue, and eyelids are pale, and sometimes there is a peculiar greenish tint in the cheeks, on account of which the name 'chlorosis' has been given to the disease. All the tissues of the body suffer from the defective nutrition, and a deficient amount of energy is set free in them; in consequence, such girls are weak, languid, and unfit for sustained mental or bodily exertion. The muscular structure of the heart is affected, there being palpitation and breathlessness on going upstairs or on taking any active exercise. Hæmic murmurs may also be heard over one or more of the cardiac orifices, and the *bruit de diable* over the veins of the neck.

There are dyspeptic symptoms, with headaches and loss of appetite, which is often capricious, and usually a preference for a diet containing a deficiency of proteids, with too great a proportion of carbohydrates.

Food is not well digested or assimilated, and there is often an excess of adipose tissue in the body; or the reverse may occur, and a thin appearance with a general want of development is seen.

The brain and nervous system are also affected, as shown by the frequent occurrence of irritability, and various other nervous or hysterical phenomena. Menstruation is generally absent or scanty, but sometimes profuse or accompanied with pain. The bowels are, as a rule, constipated.

Secondary Anæmia.

Some of the causes are: Hæmorrhage from any cause, typhoid fever, rheumatic fever, pneumonia, pleurisy, measles, diphtheria, scarlet fever, gastric ulcer, acute nephritis, syphilis, gonorrhœa, lead-poisoning, purpura, scurvy, jaundice, malarial poisoning, and the continued discharge of pus. In addition, anæmia is secondary to many chronic diseases, as chronic gastritis, cancer, Bright's disease, and valvular disease of the heart.

All of these and many other diseases cause anæmia, and after some comparatively slight affection, as an abscess, it may be present in a considerable degree, owing to the fact that the blood was in an anæmic condition before its formation.

Anæmia in Infants and Children.

Anæmia and, in consequence, deficient vitality are very prevalent among infants, and may, I believe, be largely attributed to defective nutrition in embryonic life. The ovum, during growth and development in the ovary, derives its nutriment from the maternal blood, and on the contents of it in the impregnated state the early life of the embryo is maintained; but, as Kirke observes, 'in Mammalia the office of the umbilical vesicle ceases at a very early period, as the quantity of the yelk is small, and the embryo soon becomes independent of it by the connexions it forms with the parent.'[1] Soon after its entrance into the uterus, the nutrition of the ovum is derived through the agency of the chorionic villi; these, 'at first only cellular in structure,' 'subsequently become vascular by the development in them of loops of capillaries.'[2]

Physiology shows that, although there is no direct communication between the maternal and the fœtal blood-vessels, the chorionic villi contained in the fœtal portion of the placenta are bathed in the blood contained in the sinuses of the maternal portion; that oxygen and nutrient material pass from the mother's blood into the blood-vessels contained in the villi of the chorion, and then through the umbilical vein into the fœtal circulation; that carbonic acid gas and other waste material are transmitted from the fœtal to the maternal blood; and that, as Kirke states, the placenta 'performs the functions which in later life are discharged by the alimentary canal and lungs.'[1]

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[1] 'Handbook of Physiology,' thirteenth edition, p. 803.
[2] *Ibid.*, p. 806.

If, then, the nutrient and oxygen-carrying capacity of the blood of the mother are deficient, there will be a defect in the growth, and development of the embryo.

Blood is formed at an early period in fœtal life. The blood-forming organs of the embryo are dependent on the nutrition derived from the mother, and on their healthy condition depends their capacity for the formation of red cells in normal numbers and of good quality. If the latter are defective, they will be incapable of absorbing oxygen from the maternal sinuses in the placenta in sufficient amount for normal development. Although the nutrient material and oxygen which are necessary to the life of the fœtus are derived from the mother, the degree of vitality imparted to it by the male parent naturally has an effect; and in the case where the mother had normal blood, but the father anæmic blood, and consequently insufficiently nourished spermatozoa, growth and development would be defective. Anæmia in either parent lowers its vitality, and when present in both it is still more deficient.

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[1] 'Handbook of Physiology,' eleventh edition, p. 777.

The infant of an anæmic parent has ill-developed blood-forming organs at birth, in consequence of which they are incapable of supplying red corpuscles in sufficient number or of normal quality, and thus anæmia is congenital.

Dr. Monti considers that syphilis, tuberculosis, or malaria in the mother during pregnancy are often causes of congenital secondary anæmia in infants.[1] Although congenital anæmia may be induced by these diseases, its causation may be attributed in by far the largest number of instances to an anæmic condition of the blood of one or both parents in whom there is no other constitutional disease.

Anæmia is also secondary to various diseases, as is the case in later life. Dr. Cabot remarks: 'All the signs by which sickness is shown in the blood of adults are exaggerated in children. Their blood is apparently more sensitive to the action of any morbid influence;' 'comparatively slight hæmorrhage, gastro-intestinal or respiratory disorders, which would not impoverish an adult's blood may produce considerable anæmia in a young child.'[2]

Treatment.—The benefit of iron in the treatment of anæmia is well known, and its effect in restoring the hæmoglobin in the blood can be proved by the hæmoglobinometer. With regard to the way in which iron acts in chlorosis, Dr. Osler observes: 'Iron is present in the fæces of chlorotic patients before they are placed upon any treatment.' 'Bunge believes that it is the sulphur which interferes with the digestion and assimilation of the natural iron. The sulphides are produced in the process of fermentation and decomposition in the fæces, and interfere with the assimilation of the normal iron contained in the food. By the administration of an inorganic preparation of iron, with which these sulphides unite, the natural organic combinations in food are spared.'[1]

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[1] Cabot, 'Clinical Examination of the Blood,' fifth edition, p. 515.

[2] *Ibid.*, p. 510.

When the blood is in a normal state the iron contained in food is no doubt sufficient to supply the amount the body requires for health, and in anæmia iron may act as Bunge suggests. However this may be, the oxygen-carrying capacity of the blood is gradually restored, with the result that nutrition is increased in all the tissues of the body, including those of the blood-forming organs, and when the healthy vitality of the latter is renewed, they become capable of supplying red corpuscles in sufficient number and of good quality.

Iron is found in many foods, and analysis shows that the ash of the following, among others, contains ferric oxide in various proportions: Wheat, barley, rye, rice, millet, oats, potatoes, peas, lentils, broad beans, kidney beans, and milk.[2] Iron is also present, as Dr. Landois says, in eggs and in the ash of meat.

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[1] 'The Principles and Practice of Medicine,' sixth edition, p. 730.

[2] Wynter Blyth, 'Foods: Their Composition and Analysis,' fifth edition, pp. 146-201.

In the treatment of anæmia, the main object in view is the re-establishment of the blood to its normal physiological condition, as far as red corpuscles and hæmoglobin are concerned. In the restoration, the corpuscles are renewed in number first, the hæmoglobin being regained much slower. To discontinue the medicinal treatment by iron with the renewal of the red cells—when numerically defective—to their normal number would then only partially restore the blood to a sound condition; the hæmoglobin would still be deficient.

Treatment by iron must be continued until the hæmoglobin is restored to its normal physiological proportion in the blood.

On considering the treatment of each individual, it has to be remembered that the anæmic condition may have been in existence for some time—months or years in some cases—also that it may be due to some severe illness which has reduced the strength of the whole system. With this loss of vitality, the degree varying as does that of the anæmia, the treatment requires considerable care and judgment. While iron in its action may almost be considered a food in such cases, it is also a drug of considerable power, varying in its effect according to the preparation used, and to the dose employed. There are many preparations of iron, and others than those to be mentioned are in some cases useful, but with two of them I have found that almost any case of chlorosis and secondary anæmia—except, of course, when organic disease is present—can be successfully treated as far as iron is concerned. These are the citrate of iron and ammonium and the perchloride of iron. Both are valuable, but the perchloride is of the most worth. With these two preparations the best results are obtained, and the method of their use will be chiefly considered. Of the preparations of the perchloride of iron, the one of greatest value is the liquor—that is, 1 part of the strong solution of the perchloride of iron to 3 parts of water, and known as liquor ferri perchloridi. This preparation I believe to be preferable to the tincture of the perchloride; it contains no alcohol, as the latter does, and in the weakened condition of the stomach the simpler preparation is better borne. While the distinction between the tincture and the liquor is not great, the preparation tolerated the best is the most suitable. Quinine and liquor arsenicalis, which are sometimes necessary in the treatment, also combine well with the liquor. The acid contained in this preparation is sufficient to stimulate the flow of gastric juice, and so aids digestion, in addition to its action as a hæmatinic.

The dose which should be given is important. The administration in full doses at first is to be avoided, as, owing to the weakened condition of the stomach and of the system as a whole, they are not tolerated well. The better method is to begin with a small dose, and gradually increase it.

Iron has been prescribed with various other ingredients—as calumba, quassia, magnesium sulphate, spirits of chloroform, and bicarbonate of potash or soda, with the ammonio-citrate. The indication is to give it in the combination which is most easily borne by the weakened digestive organs that would be in the least complicated. It is best taken, and effects its object better, given alone—except in those cases where arsenic or quinine are indicated—whether in the form of the ammonio-citrate or the perchloride, with a little glycerine or syrup, and dissolved in water.

In chlorosis, or in secondary anæmia when the hæmoglobin percentage is 40 to 50 per cent., 3 grains of the ammonio-citrate, with 5 drops of glycerine, and water to an ounce, can be given three times daily after food for five or six days; at the end of this time the dose may be increased to 5 grains, and continued or increased to 7 grains, until this preparation has been taken for three or four weeks. Then the perchloride may be commenced, 3 to 4 minims of the liquor being given in glycerine and water three times daily for a few days, and then increased to 5 minims.

This dose will be found in many cases sufficient to continue with, especially in those who, debilitated as they are by the disease, are not of the more robust type of constitution. In a case of anæmia when the hæmoglobin is reduced to 50 per cent., its restoration will take at the least three to four months. There is much to be done, for the system must be built up by means of food, air, and iron, and the nerves, with all the other tissues and structures, restored to a healthy condition by gradually increasing the quality of the blood.

When thought advisable, at the end of a fortnight the perchloride of iron may be increased to 7 minims three times daily, and then later to 10 minims. More than 10 minims three times daily is seldom necessary in those who must take the preparation for lengthened periods.

Iron usually causes constipation, but in the less severe cases, when exercise is taken, this is not always the case. Constipation is best relieved by the use of pills—in women, when menstruation is absent, by the use of those containing aloes, as the aloes and myrrh pill, or aloes and socotrine pill of the pharmacopœia; later, when the menstrual function is established, but the hæmoglobin is still deficient in the blood, the colocynth and hyoscyamus pills are effective. These latter pills are also suitable in the treatment of men. Pills should not be given every night. Dr. Halliburton says: ‘About twelve hours are occupied by the journey of an ordinary meal through the small intestine, and twenty-four to thirty-six hours by the passage through the large bowel.’[1] If, then, the contents are expelled too soon from the intestine, digestion and absorption are not thoroughly accomplished. The nervous system also regains its stability in less time without more frequent purgation than is necessary. To obtain a free evacuation every two or three days is generally sufficient when there is constipation, the bowels usually acting to some extent between the taking of the pills. For the same reason, to avoid too frequent purgation, the combination of magnesium sulphate with the perchloride mixture is not, as a rule, advisable. Carbonate of iron in the form of Blaud's pills suits some, but the above routine is the more effective in most persons. When iron has to be taken for long periods, it is beneficial to have a few days' intermission from the treatment occasionally, and then continue again until the hæmoglobin is restored to the normal proportion in the blood. During the treatment rest from work is generally necessary in the more severe forms, and in milder cases it is better, especially when the occupation entails considerable mental application.

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[1] ‘Handbook of Physiology,’ sixth edition, p. 533.

Fresh air, without violent exercise, and good food are also needed, and, as a rule, no alcohol should be taken while under treatment. There are instances when iron is indicated and patients are convinced that it does not agree with them, but by beginning with small doses this idea may be overcome. The confidence with which its action and necessity can be spoken of, the knowledge that it is the one drug required to restore the deficient hæmoglobin, and the accuracy with which the absence of the normal amount can be discovered by means of the hæmoglobinometer, afford a scientific method of discovering the deficiency, and definite reasons for the need of its restoration.

Arsenic in combination with iron is especially indicated when anæmia is complicated with eczema, also in some cases of enlarged glands; and it is valuable when various nervous or hysterical symptoms are present.

I have known such cases to be relieved by a combination of these two drugs when other methods have been ineffectual. With respect to the action of arsenic, Dr. Mitchell Bruce says that it increases metabolism and nutrition, and is found in the grey matter of the spinal cord, where 'it acts by diminishing the sensibility and reflex irritability of the centres.'[1]

In the treatment of anæmia combined with neuroses there is thus often an indication for the use of arsenic, and it aids in the restoration to health by increasing nutrition and diminishing nervous irritability.

When arsenic is prescribed, a dose proportionate to that of iron should be given, 2½ minims of liquor arsenicalis being administered with 5 grains of the ammonio-citrate or 5 minims of the liquor ferri perchloridi, and 5 minims with 10 grains of the ammonio-citrate or 10 minims of the liquor ferri perchloridi.

When the combination of these preparations of iron with arsenic is needed, the use of Fowler's solution is preferable to that of the liquor arsenici hydrochloricus, and its therapeutic effect of far greater benefit.

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[1] 'Materia Medica and Therapeutics,' 1899, p. 113.

Quinine in combination with iron is sometimes useful in the treatment of anæmia, and the beneficial effect of it may be attributed, not to any direct action on the blood but to the result produced in the system generally.

In the blood Dr. Mitchell Bruce considers that it acts by binding 'the oxygen more firmly to the hæmoglobin, so that oxygenation is less easy and less active.'[1]

In the alimentary canal it has, in small doses, the action of a bitter, and so improves digestion; it also has a stimulating effect on the heart and on the respiration.

Its use is not indicated, nor is it beneficial in all cases of anæmia. In the treatment of children it is seldom needed, and in chlorosis or severe degrees of anæmia is not, as a rule, required. Its administration is particularly of value in cases of secondary anæmia in adults, when, in addition to the effect produced in the blood, the system as a whole is depressed. Even in such cases it is not required throughout the whole course of treatment, and in anæmia following, for instance, typhoid or rheumatic fever, with the hæmoglobin reduced to 50 per cent., is not usually needed until the hæmoglobin is restored to about 80 per cent., when, if the depression is not recovered from proportionately to the improvement effected in the nutrition of the body as a whole, it may be added to the iron mixture.

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[1] 'Materia Medica and Therapeutics,' 1899, p. 310.

When quinine is given, ½ to 1 grain, and occasionally to 2 grains, is the dose that is generally required. It dissolves readily in the liquor ferri perchloridi, and when this combination is indicated, has a better effect without the addition of further acid.

Strychnine should, if possible, be avoided in the treatment of anæmia, and in the great majority of cases is not necessary.

With regard to the action of strychnine on the blood, Dr. Mitchell Bruce remarks: 'Here it affects both the red corpuscles and the plasma, reducing the absorptive power of the former for oxygen, and the discharge of carbonic acid from the latter;'[1] and with regard to its action on the nervous system, that it increases the reflex excitability of the motor centres of the cord.

These effects produced by strychnine are contra-indicated in anæmic conditions, and the most satisfactory results are obtained by the use of iron alone, or combined in some cases with arsenic, in others with quinine. The effect strychnine has in stimulating the action of the heart and increasing the peristaltic movements of the muscular coat of the intestines is not often needed, for a healthy state of the muscular structures of the heart and intestinal walls is induced, owing to the increased nutrition derived by restoring the blood to its normal condition.

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[1] 'Materia Medica and Therapeutics,' 1899, p. 338.

Mercury is seldom of use in pills, and is better left out; it has a depressing effect on the system, and anything tending in that direction in anæmic conditions, when the vitality is already reduced, should be avoided. Dr. Mitchell Bruce says the excessive use of mercury impairs nutrition, and 'induces impoverishment both of the plasma and corpuscles, indirectly referable to the drug,'[1] and that it should not be given as an alterative 'in persons with anæmia or debility, unless these are distinctly referable to syphilis, and even then it must be employed with caution.'[2]

In children the beneficial effect of iron is particularly seen, and when indicated there is no drug tolerated better. As a general rule, in children under seven years of age the ammonio-citrate is the best preparation, and after that age either this or the perchloride may be administered. The ammonio-citrate can be given in ½, 1, 1½, 2, 3, or 4 grain doses, and similarly, when the perchloride is needed the dose can be regulated according to the age and constitution of the child. Arsenic may be added to the iron mixture when indicated. In the treatment of infants, syrupus ferri phosphatis or vinum ferri are sometimes useful, but the ammonio-citrate is, I believe, preferable to any other preparation.

In children there is less tendency to constipation during treatment than in the case of adults, but when necessary a powder, such as the compound rhubarb or the compound liquorice, gives the necessary relief.

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[1] 'Materia Medica and Therapeutics,' 1899, p. 101.

[2] *Ibid.*, p. 106.

As in adults, the treatment should be continued until the hæmoglobin is restored to its normal proportion in the blood.

Objections to taking Iron.

The following are sometimes made:

1. That it discolours the teeth. This is unimportant when iron is necessary. There are combinations with iron which discolour the teeth to some extent, as the sulphate with acids, but the ammonio-citrate and the perchloride of iron have only the slightest effect in this direction. The ordinary use of the toothbrush daily usually prevents it. Any slight discoloration that may occur has no permanent effect on the enamel, and is easily removed by gently scraping, or, on the completion of treatment, by the dental surgeon's brush.

2. That it deranges digestion. Any such effect is, as a rule, entirely owing to the preparation or combination with the iron being unsuitable, or to the dose being too large. With the uncomplicated combinations above there is no derangement of digestion, but the reverse occurs, and by the administration of iron at the same time that the blood is restored the stomach regains its tone and digestion is improved.

3. That it causes constipation. This often, but not

always, occurs, and in some the effect is slight; in any case, all that is required is the use of pills during treatment.

Iron leaves, as a rule, no after-effects in this direction, and on making inquiries, the statement is usually made that, whereas in the anæmic condition there was constipation, when this has been remedied, and the course of iron is concluded, the bowels gradually resume their normal activity. This is due to the general beneficial effect iron has in strengthening the whole system, in increasing the tone of the muscular and other tissues of the intestinal walls, and also to the more complete digestion of food.

CHAPTER III.

DIGESTION.

The necessity that the individual should have a suitable supply of food, and that its digestion should be satisfactorily accomplished, in order that health may be maintained, is well known, and will be referred to later on.

Digestion in its relation to the blood, in health, and in anæmia, may now be considered.

The physiology of digestion shows that the main forces concerned in the process are those occasioned by muscular action and by the secretions of various glands, and subsequently the absorption of the constituents of food by the lacteals and blood-vessels, the nervous system having a controlling influence over the various physiological processes.

For efficient digestion sound blood is essential, in order that the healthy condition of the tissues, glands, and nerves concerned may be maintained.

The digestive process commences in the mouth; here the food is ground by the teeth, the secretion of the salivary glands is poured out, and starch is converted into sugar. The essentials for normal digestion, as far as the mouth is concerned, are good teeth, a healthy mucous membrane, a normal salivary secretion, a sound condition of the muscles of the tongue, and of those concerned in the movements of the jaw.

The tissues of all these structures, of the salivary glands and of salivary cells, whose function it is to secrete and form the saliva, are dependent on the blood for their nutrition and health.

All epithelial cells, which are the active secreting agents in the various glands, rely on the nutrition derived from the blood.

Dr. Halliburton remarks: 'Epithelium has no blood-vessels; it is nourished by lymph. When the blood is circulating through the thin-walled blood-vessels in the tissues beneath the epithelium, some of its fluid constituents escape. This fluid is called lymph; it penetrates to all parts of the cellular elements of tissues and nourishes them.'[1]

In the stomach the essentials for normal digestion are that the serous, muscular, submucous and mucous coats which form its wall shall be in a healthy state; and the nutrition of all of them is sustained by the blood.

A sound condition of the layers of the muscular coat is an important requirement for gastric digestion. By the contractions the food is compressed and thoroughly mixed with the gastric juice; the wall is kept in contact with it, and so absorption is aided; and when it becomes chyme is propelled by them through the pyloric orifice into the duodenum.

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[1] 'Handbook of Physiology,' sixth edition, p. 33.

The mucous membrane supports the gastric glands, and in order that the secreting cells may be enabled to perform their normal function of secreting and forming the gastric juice, a healthy blood-supply is needed.

With regard to the part taken by the stomach in digestion, while this organ has important functions through the medium of the gastric juice in converting proteids into peptones, and in dissolving the saline constituents of food and cane-sugar, it is to a large extent occupied in reducing the food to the consistency of chyme, and thus preparing it for the further processes of digestion in the intestine.

In the small intestine, that the serous, muscular, submucous, mucous coats, glands, and villi, which form its wall, should be in health is of great importance, and all these structures are dependent on the blood for their nutrition.

It is in this part of the alimentary canal that digestion and absorption take place to a large extent; here also peristaltic movements are most vigorous. In the digestive process in the small intestine two glands external to its wall are concerned, the liver and the pancreas, and for the maintenance of the sound condition of their tissues and secreting cells, and of the bile and pancreatic juice which are poured out into the duodenum, normal blood is essential.

With respect to absorption, Sir Michael Foster says: 'We have seen that absorption does, or at least may, take place from the stomach. We have also stated that a large absorption, especially of water, occurs along the whole large intestine. Nevertheless, it is during the transit of food along the small intestine that the largest and most important part of the digested material passes away from the canal, partly into the lacteals, partly into the portal vessels.'[1]

In the large intestine the tissues and glands which compose the wall are equally sustained, as are the structures of the rest of the alimentary canal, by the nutrition derived from the blood.

The peristaltic movements are not so vigorous as in the small intestine, but a healthy condition of the muscular coat is important, not only for the action it has in assisting digestion and absorption, but also that the contractions may take their normal part in the act of defæcation in combination with those of other muscles external to the intestinal wall.

Kirke says that peristalsis, 'especially of the sigmoid flexure,' 'is a very important part of the act.'[2]

Various views are held with regard to the part taken by the large intestine in digestion. Sir M. Foster expresses the opinion that whether or not digestion is completely accomplished at the ileo-cæcal valve, an important function of the colon is the absorption of water, and the soluble constituents of the chyme.[1]

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[1] 'Textbook of Physiology,' part ii., sixth edition, p. 507.

[2] 'Handbook of Physiology,' eleventh edition, p. 357.

The beneficial effect of nutrient enemata, as Kirke observes, also indicates the capability of the large intestine 'to digest fatty, albuminous, or other matters'; but he considers that in the healthy condition the main results are the absorption of the more liquid parts of the chyme, and probably 'the completion of the changes which were proceeding in the small intestine.'[2]

For sound health normal digestion is a necessity. In anæmia, owing to the deficient nutrition derived from the blood, the tissues of the secreting glands, the secreting cells, the secretions, and the muscular and other tissues of the digestive system, are in a defective condition, in consequence of which they are incapable of satisfactorily fulfilling their functions.

With imperfect digestion there will be inefficient absorption.

The capacity of the epithelial cells, blood-vessels, and lacteals to fulfil their normal functions in absorption depends on their healthy condition, and also largely on the capability of the digestive process to reduce the food into a substance suitable for its accomplishment. Muscular action also aids by adjusting the wall of the alimentary canal to its contents.

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[1] 'Textbook of Physiology,' part ii., sixth edition, p. 505.

[2] 'Handbook of Physiology,' eleventh edition, p. 356.

The nervous system, exercising as it does a controlling action over the physiological processes of digestion, is still dependent for its healthy state and the ability to fulfil its normal functions on the nutrition derived from the blood, and in anæmia such effect will also be defective.

CHAPTER IV.

AN INVESTIGATION INTO THE NATIONAL PHYSIQUE.

On commencing practice at Lewes in Sussex at the latter end of the year 1892, I shortly noticed the prevalence of anæmia, and obtained an insight, during ten months' residence, into the physique of the inhabitants both in the town and in the neighbouring villages.

Soon after leaving Lewes I was engaged in medical work in Brighton, and there had an opportunity of seeing the condition of the physique of the inhabitants. I then left Sussex, but returned in the year 1900, to take up work at Alfriston and some adjoining parishes—a district situated between Lewes and Eastbourne.

The experience of over two and a half years' practice in or near Eastbourne, Lewes, Seaford, Newhaven, and Brighton, as well as the occasions of several recent visits to the last-named town, have afforded me much opportunity for observations as to the physical capacity of the population.

This part of the country cannot be decribed as anything but one of the best from a health point of view. In the seaside towns and in the inland villages, backed by the Sussex downs, presenting large areas almost unpopulated, the atmospheric environment can hardly be surpassed. In this district anæmic conditions are prevalent to a considerable extent, and but for this everything would tend to healthy physical development. I have also noticed the prevalence of anæmia in many towns and villages in the South of England in addition to the places named, among which are the following: Folkestone, Hastings, St. Leonard's, Bexhill, Worthing, Weymouth, and Torquay. In Devonshire—at Axminster, Exeter, Okehampton, and in the surrounding villages; also in the neighbourhood of Newton Abbot; in Hampshire—at Basingstoke and in the surrounding district; in Kent—at Maidstone, Chatham, Rochester, Strood, Gravesend, and Sidcup.

In these urban and rural centres, some of which are well known health-resorts, the atmospheric environment favours the development of sound individuals.

I have noticed anæmia to be prevalent in all parts of the Midlands into which I have been, inclusive of the following places:

Cheshunt, Hatfield, St. Albans, and in the adjoining villages; Reading, Oxford, Woodstock, and Bicester—in the district surrounding the three latter, where the occupation of the inhabitants is almost entirely of an agricultural nature, it is prevalent to a considerable extent;

Newport Pagnell, Stony Stratford, Wolverton, and in some of the adjacent villages;

Birmingham, Warwick, Leamington, Stratford-on-Avon, Coventry, Northampton, Kettering, and in the surrounding district;

Leicester, Nottingham, Derby, Matlock, Leek; and among the mining population of North Derbyshire, at Eckington and in the neighbouring villages.

In a number of cities, towns, and villages in the North of England I have noticed anæmia to be very prevalent.

In Lancashire—at Liverpool, Manchester, Oldham, and Rochdale. In Oldham it is especially evident, and the impression conveyed was that I had never seen such pallid faces as among the young women engaged in the factories there.

In Yorkshire—in Sheffield, Doncaster, Pontefract, Bradford, Wakefield, and in the adjoining villages.

At Leeds I noticed its prevalence among the factory workers, in many of whom the decay of the teeth is a prominent feature.

Yorkshire, with its large rural area and moorland districts, has an atmospheric environment which is very favourable to the growth and development of a robust population, and if the blood of the inhabitants was in a normal condition, such would no doubt be the case to a greater extent.

I have also noticed the prevalence of anæmic conditions in the West of England—in Gloucester, Bath, Bristol, Staple Hill, and in the surrounding villages.

In Monmouthshire — at Newport, Abergavenny, Ebbw Vale, and in the adjacent district.

In the Eastern Counties I have noticed the prevalence of anæmia at Cromer, Yarmouth, Gorleston, Felixstowe, and Harwich ; in these places the air has the well-known bracing qualities of the East Coast. At Fakenham, Ipswich, Colchester, Bury St. Edmunds, Cambridge, Newmarket, and in the neighbouring villages.

In Wales I have noticed anæmia to be prevalent in Brynmawr, Cardiff, Swansea, Brynamman, and in the contiguous district.

In an investigation with regard to the physique of the inhabitants of London, as well as having practised the profession in twelve different districts, I have spent much time in the observation of all classes —in private houses, in the streets, in the parks, and under innumerable circumstances of city life.

In many of the districts of London I have made observations, and have practised for varying periods extending over two years at Fulham, Pimlico, Maida Vale, and Shepherd's Bush in the west ; at Tottenham in the north ; at Lewisham, Brockley, and Plumstead in the south ; at Shoreditch, Mile End, Poplar, and Plaistow in the east.

In those districts in the East End into which I have been I have not noticed anæmic conditions to be more apparent among the British working-class population than in other parts of London.

The physical state of the inhabitants of London reflects that of the population of the country as a whole. Anæmia is prevalent in all the districts I have been into.

Observations have been made in cities, towns, and villages representative of manufacturing, mining, and agricultural centres, and I have visited many other places in addition to those named. Wherever I have been I have made observations in all the villages within reach that time would allow, and thus an investigation has been completed into the physique of the population of a large part of England from various points of the compass.

While some parts of the country are more conducive to robust health — as, for instance, rural districts as opposed to crowded town centres—in the great majority of districts—in fact, I can think of no places where the environment is distinctly against health—existing conditions favour efficient physical development; but neither one place nor another is given the full opportunity for the development of healthy individuals, unless the blood is sound and not deficient in the hæmoglobin constituent.

According to the position in life, housing, food, and clothing vary; but investigations have been made with the object of gaining a comprehensive view of the physique of the ordinarily successful in all classes of society.

Naturally it is reasonable to suppose that those having all that should induce health, such as good housing, food, clothing, and atmospheric environment, would benefit to a greater degree than those in a less fortunate position, and this is so to a certain extent; but physiological facts concerning the blood show that, unless hæmoglobin is present in the proper amount, it is incapable of absorbing a sufficient quantity of oxygen for nutrition and oxidation to be normally carried on, in order that growth and development and the functions of the various tissues and organs of the body may continue, to the best advantage of the individual's health.

With regard to the sanitary environment in the various towns and districts, greatly improved as most parts of England have been, and especially in comparatively recent years, the great majority of the population are living under such conditions as to be most favourable to sound health; and in none of the places I have visited would it be possible to attribute lack of physical development in any great degree to defective sanitation.

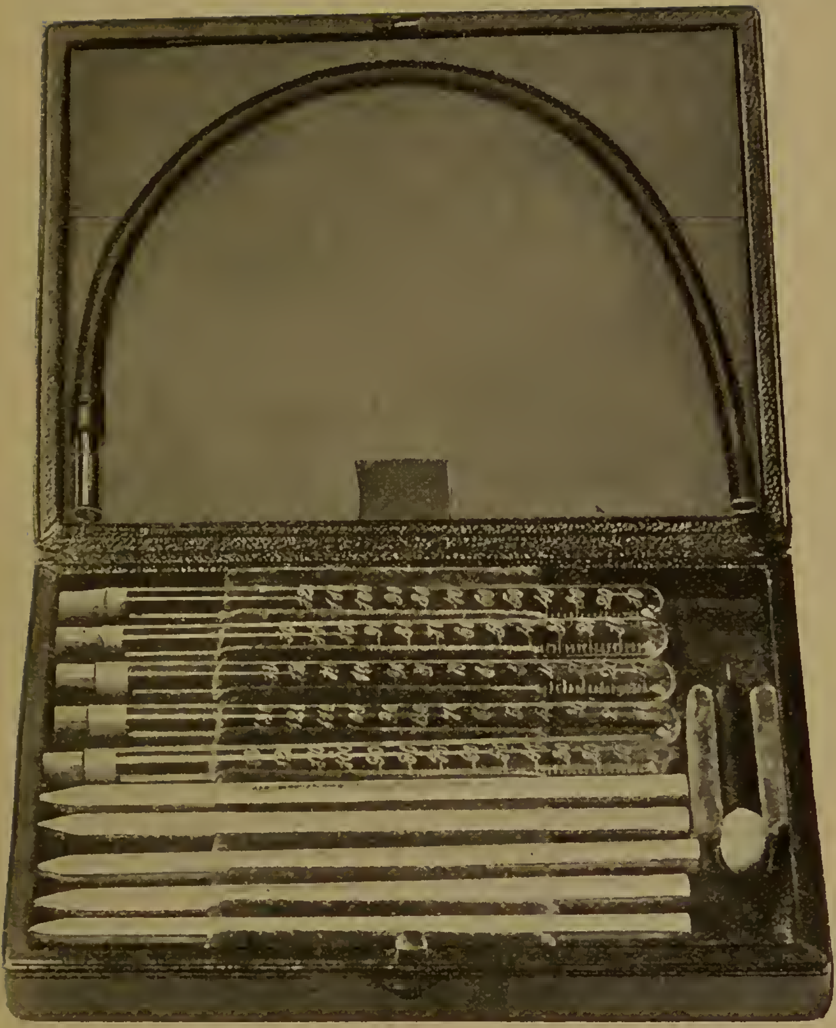
CHAPTER V.

THE RESULTS OF ANÆMIC BLOOD-TESTS.

In order to be in a position to estimate the amount of hæmoglobin in the blood of individuals during visits from house to house, I made preparations so that I could take every advantage when opportunities should occur.

The question of what hæmoglobinometer should be used had to be decided to a large extent on the greater convenience of one instrument than of another, as the estimation can be effected with several. The instruments called 'Gower's hæmoglobinometer' and 'Haldane's modification of Gower's hæmoglobinometer' I decided to use in the investigation. In the estimation of hæmoglobin with the latter coal-gas is needed in the test, and in country villages this is not always at hand, therefore the former was necessary. By having both instruments I could also make doubly sure of their correctness by occasionally testing the same individual's blood with both prepared standards; this I have done, and have found that the accuracy of the test is assured with either.

That several specimens of blood might be obtained



CASE CONTAINING PIPETTES, GRADUATED TUBES, PUNCTURING NEEDLE, AND SUCTION APPARATUS.

To face p. 50.

in the same morning or afternoon, a case was made to contain five capillary pipettes, five graduated tubes, the suction apparatus and puncturing needle; also another case to hold and protect the small bottle of distilled water. I was thus in a position to take specimens of blood from five different individuals, and on returning home the tests were completed with the prepared standard.

The object of the tests was to estimate the quantity of hæmoglobin in the blood, not of those suffering from any disease or complaint, but of those going on with their occupations and in their usual health; and although tests have been made of the blood of patients suffering from various diseases, in the following account these are excluded, and only the results of the estimation in those in their ordinary health are tabulated.

The method that I adopted in order to obtain the specimens of blood was to take them from the finger of any friends or relatives who were in the house of a patient I was attending. In the case of boys the offer of a small coin brought many to undergo the slight puncture; in the case of men some of the specimens were secured whilst they were at work.

The blood of individuals was tested in six representative urban or rural districts of England. In the North, at New Sharlston, Sharlston Common, Streethouse, Warmfield, and Crofton, Yorkshire villages situated about three miles from Wakefield. In the South, in London—among boys between the age of seven and fourteen years, the tests were made at Bromley, in the neighbourhood of the termination of the Bow Road, and among other individuals in various districts. In the East, at Fakenham, a country town with a population of 3,000, the centre of an agricultural district, and stationed in Norfolk about twenty miles inland from Cromer. In the West, at Bristol. In the Midlands, at Castlethorpe, Hanslope, and Long Street, villages in Buckinghamshire lying five or six miles from Wolverton, and at Oxford. In the latter centre only the blood of men and of boys over fourteen years was tested.

The tests are grouped according to sex and age thus: boys from seven to fourteen years; girls from seven to fourteen years; women from eighteen to forty years; children below seven years; boys from fifteen to seventeen years; men from eighteen to forty years.

With regard to the details of the results obtained by estimating the amount of hæmoglobin in the blood of individuals, those concerning boys between the age of seven and fourteen years can first be referred to.

The blood of boys of this age was tested in the five centres in Norfolk, London, Yorkshire, Bucks, and Bristol, and a comparison may be made between that of those in the three former. All the boys whose blood was examined had the appearance of being well fed, were well clothed, and the sons of the respectable working classes.

In Norfolk, 12 per cent. had a hæmoglobin percentage of 90 to 100; in 64 per cent. it was 80 to 90, and in 24 per cent. 70 to 80.

The average hæmoglobin percentage was 83.

In London, 19 per cent. had a hæmoglobin percentage of 90 to 100; in 50 per cent. it was 80 to 90, and in 31 per cent. 70 to 80.

The average hæmoglobin percentage was 82.

In Yorkshire, none had a hæmoglobin percentage of 90 to 100; in 78 per cent. it was 80 to 90, and in 22 per cent. 70 to 80.

The average hæmoglobin percentage was 80.

Of the total number of boys in the five centres, 15 per cent. had a hæmoglobin percentage of 90 to 100; in 57 per cent. it was 80 to 90, and in 28 per cent. 70 to 80.

The average hæmoglobin percentage was 80$\frac{3}{5}$.

It is thus seen that the average hæmoglobin percentage in the blood of boys in two districts—one in Norfolk, situated in the heart of the country, the other in Bromley, a thickly populated district of London—was nearly the same—83 in the Norfolk boys and 82 in the Bromley boys; also that 12 per cent. of the Norfolk boys and 19 per cent. of the Bromley boys had a percentage of 90 or above—that is to say, the blood of only this small proportion in the two districts approached to normal.

That 7 per cent. more of the Bromley boys than of those living in the purer air of the eastern county had a hæmoglobin percentage of 90 or above shows that a sound condition of the blood may be maintained in the environment of a crowded city area.

That 7 per cent. more of the Bromley boys than of the Norfolk boys had a hæmoglobin percentage of 70 to 80 suggests that when there is a defective percentage of 80 to 90, the blood of more of those living in city surroundings than of those in a rural district deteriorates still further, until it is below 80.

Further evidence of such a result is shown with regard to the Yorkshire boys, for while none of them had a hæmoglobin percentage of 90 or above, 9 per cent. less than of Bromley boys had a percentage of 70 to 80.

In Norfolk and Bromley, 92 was the average hæmoglobin percentage in the blood of boys in whom it was 90 or above; 75 in Bromley, and 74 in Norfolk, was the average percentage in those in whom it was 70 to 80.

Thus, there was an average difference of 17 per cent. between the hæmoglobin percentage in the two sets of boys in Bromley, and of 18 per cent. between those in Norfolk.

The effect such a considerable variation in the oxygen-carrying capacity of the blood has in the degree of growth and development was especially indicated when that of several boys was tested on the same occasion.

In one instance the blood of two boys was examined, one twelve years of age, the other thirteen years; the boy aged twelve had a hæmoglobin percentage of 98, and in the boy aged thirteen it was 72. The former, although the younger, was 3 inches taller, broader in the shoulders, better developed in every way, and with the ruddy face denoting health; the other was pale, ill-developed, and his whole appearance showed want of muscular tone and vigour. In another instance, the blood of two boys was examined, both aged thirteen; one had a hæmoglobin percentage of 92, in the other it was 84. The physique of the former was superior to that of the latter.

Of girls whose blood was tested between the age of seven and fourteen years, a comparison may be made between that of those in the country villages in Yorkshire and Bucks and of those in Bristol.

In Yorkshire, 40 per cent. had a hæmoglobin percentage of 80 to 90, and in 60 per cent. it was 70 to 80.

The average hæmoglobin percentage was 78.

In Bucks, 63 per cent. had a hæmoglobin percentage of 80 to 90, and in 37 per cent. it was 70 to 80.

The average hæmoglobin percentage was 80.

In Bristol, 50 per cent. had a hæmoglobin percentage of 80 to 90, and in 50 per cent. it was 70 to 80.

The average hæmoglobin percentage was 78.

Of the total number of girls in the three centres, 51 per cent. had a hæmoglobin percentage of 80 to 90, and in 49 per cent. it was 70 to 80.

The average hæmoglobin percentage was $78\frac{2}{3}$.

It is seen that a larger proportion of them had a low hæmoglobin percentage of 70 to 80 in Yorkshire than in the other districts, and that there were more in Bristol than in Bucks.

In 12·5 per cent. of all the girls in the three centres, a hæmoglobin percentage as near to normal as 86 was reached, but, as shown, none of them had a percentage of 90 or above.

Of women whose blood was examined between the age of eighteen and forty years, a comparison may be made between that of those in the four centres in Bristol, Bucks, London, and Yorkshire.

In Bristol, 14 per cent. had a hæmoglobin percentage of 90 to 100; in 57 per cent. it was 80 to 90; in 15 per cent. 70 to 80; and in 14 per cent. below 70.

The average hæmoglobin percentage was 80.

In Bucks, 27 per cent. had a hæmoglobin percentage of 90 to 100; in 37 per cent. it was 80 to 90; in 18 per cent. 70 to 80; and in 18 per cent. below 70.

The average hæmoglobin percentage was 81.

In London, 17 per cent. had a hæmoglobin percentage of 90 to 100; in 50 per cent. it was 80 to 90; in 17 per cent. 70 to 80; and in 16 per cent. below 70.

The average hæmoglobin percentage was 80.

In Yorkshire, none had a hæmoglobin percentage of 90 to 100; in 47 per cent. it was 80 to 90; in 41 per cent. 70 to 80; and in 12 per cent. below 70.

The average hæmoglobin percentage was 78.

Of the total number of women in the four centres, 14·5 per cent. had a hæmoglobin percentage of 90 to 100; in 47·75 per cent. it was 80 to 90; in 22·75 per cent. 70 to 80; and in 15 per cent. below 70.

The average hæmoglobin percentage was 79¾.

The tests thus show that anæmic conditions are prevalent among women in all the districts, but are most so in Yorkshire; also, that although in Bucks a greater proportion had a hæmoglobin percentage of 90 or above than in the other centres, in a large number of women it was below 80, and in half of the latter below 70.

On comparing the blood of girls between the age of seven and fourteen years with that of women between the age of eighteen and forty years in the centres in Bristol, Bucks, and Yorkshire, it is seen that, while none of the girls had a hæmoglobin percentage of 90 to 100, a proportion of the women had; and that, while it was not below 70 in any of the girls, in a proportion of the women it was.

It thus appears that after the age of fourteen, until eighteen years and above, the percentage of hæmoglobin in the blood of some females increases to above 90, while in others it decreases to below 70.

Of children of both sexes whose blood was tested below the age of seven years, a comparison may be made between that of those in the four centres in Bucks, Yorkshire, Bristol, and London.

In Bucks, 50 per cent. had a hæmoglobin percentage of 80 to 90, and in 50 per cent. it was 70 to 80.

The average hæmoglobin percentage was 80.

In Yorkshire, 12 per cent. had a hæmoglobin percentage of 80 to 90; in 63 per cent. it was 70 to 80; and in 25 per cent. below 70.

The average hæmoglobin percentage was 73.

In Bristol and in London, 50 per cent. had a hæmoglobin percentage between 80 and 90, and in 50 per cent. it was 70 to 80.

The average hæmoglobin percentage in both was 81.

Of the total number of children in the four centres, 40·5 per cent. had a hæmoglobin percentage of 80 to 90; in 53·25 per cent. it was 70 to 80; and in 6·25 per cent. below 70.

The average hæmoglobin percentage was 78¾.

It is thus seen that the blood of children of this age had much the lowest hæmoglobin percentage in Yorkshire, in the same centre that the blood of women and older children had the least percentage.

In 14 per cent. of all the children in the three districts a hæmoglobin percentage as near to normal as 88 was reached, but, as shown, none of them had a percentage of 90.

The blood of boys aged fifteen, sixteen, and seventeen years was tested in the centres in London and in Oxford, the majority being in the latter. All of them were engaged in occupations as labourers.

In Oxford, 29 per cent. had a hæmoglobin percentage of 90 to 100, and in 71 per cent. it was 80 to 90.

The average hæmoglobin percentage was 89.

Of the total number of boys in the two centres, 30 per cent. had a hæmoglobin percentage of 90 to 100, and in 70 per cent. it was 80 to 90.

The average hæmoglobin percentage was 89$\frac{1}{5}$.

It is thus seen that among boys of this age who were engaged in healthy out-door occupations, less than a third had blood which contained hæmoglobin approaching to the normal percentage.

The blood of men from eighteen to forty years was examined in the centres in Norfolk, Bristol, Bucks, London, and Oxford.

In Oxford, 19 per cent. had a hæmoglobin percentage of 100 or above; in 44 per cent. it was 90 to 100, and in 37 per cent. 80 to 90.

The average hæmoglobin percentage was 92.

Of the total number of men in the five centres, 14 per cent. had a hæmoglobin percentage of 100 or above; in 49 per cent. it was 90 to 100; in 34 per cent. 80 to 90; and in 3 per cent. below 80.

The average hæmoglobin percentage was 91.

The highest percentage of hæmoglobin in the blood of any of the men was 102, and the lowest 78. The men in Oxford belonged to the class of labourers, and also, of the total number, with the exception of 5 per cent., all were included in the same class.

That, of such workers, 37 per cent. had a hæmoglobin percentage from 10 to 22 per cent. below normal must be considered a high proportion.

In Oxford, the atmospheric environment is good, labourers are engaged in an open-air occupation, and the fittest are most likely to obtain employment; they are thus in a favourable position to maintain health.

The tests show the large number of boys who are growing up with defective blood, and between the age of fifteen and eighteen years many of the unfit are weeded out, so that they are not found among the class of regular workers. This reason, and also that the hæmoglobin percentage is normally higher, will account for the larger proportion of boys above fourteen years of age than of those below having blood with a percentage of 90 to 100.

On comparing the blood of men from eighteen to forty years with that of boys, it is seen that a larger proportion of men than of boys had blood with a hæmoglobin percentage of 90 or above. This can also be accounted for partly by the exclusion of the less fit, and partly that normally the percentage is higher at the adult age.

The tests thus show that, in the first six districts in which an opportunity occurred for estimating the amount of hæmoglobin that was present in the blood of the inhabitants—and making them without any selection of individuals—anæmic conditions are prevalent to a considerable extent, especially among women and children; and had they been made in any other district into which I have been, observations made justify the conclusion that the results would have been substantially the same.

CHAPTER VI.

THE CAUSES OF PHYSICAL DETERIORATION.

An investigation into the causes of the decline in the physique of the individual, and of the population as a whole, shows that there are influences which tend to induce it, and others which tend to aggravate and increase such defects as may be present; but, drawing conclusions from observations which have extended over a large part of England, and from the results of the estimation of hæmoglobin in the blood of men, women, and children, I have formed the opinion that the main cause of physical deterioration is to be found in the defective quality of the individual's blood.

The tests show that in many instances the blood is deficient in hæmoglobin, and in consequence oxygen contained in the air, which is one of the main necessities for the life of the body and of the various structures contained in it, is absorbed in deficient amount.

Unless oxygen is absorbed in the normal quantity, and is conveyed to the tissues by means of the hæmoglobin contained in the red corpuscles of the blood, nutrition and oxidation are not effected to a degree sufficient to maintain their health, and for the renewal of the wear and tear which is constantly going on in them.

Whatever formation of body may be imparted by the parents, unless the blood of both is of such quality as to be capable of conferring healthy vitality to the spermatozoa in the male and to the ovum in the female, the creation of a new life from the time of conception will be imperfect; and unless the blood of the mother is of the quality necessary to supply the requisite oxygen and nutriment to the developing embryo during the various stages of intra-uterine life, the new-born child will begin its separate existence physically defective.

The results of observations and blood-tests go to prove that anæmia is prevalent among men and women, and that large numbers of infants are born deficient in the vitality which would be theirs were the parents' blood sound, and consequently their health of a more robust character.

An examination of the blood of children at various ages shows that it is defective in quality in large numbers of them, and in consequence they are not in possession of the health, strength, and development which should normally be present.

Food.

The food-supply and its influence on the individual's physique can first be considered.

Food and oxygen are two of the main essentials for the life of the tissues, and of the body as a whole. The digestive process, commencing in the mouth and continued in the stomach and intestinal tract, has for its object the conversion of the food into nutrient material suitable to be conveyed to the tissues, and, in combination with oxygen, to enable the metabolism to be completed whereby their nutrition is normally maintained.

The oxidation that takes place is a chemical process which is necessary to their life, and in order that it may be satisfactorily effected, sufficient oxygen must be absorbed by the blood, and however suitable in quality, quantity, and constituents the food may be, unless the proper amount of oxygen is conveyed to them, they will not derive the nutrition that is needed for the maintenance of their normal health and activity.

When the blood is in an anæmic condition, the glandular, muscular, and other structures of the digestive system are ill-nourished, and are incapable of effecting their normal purpose in digestion and absorption. These functions being imperfectly performed, such nutrient matter as is absorbed is conveyed by the blood to the tissues, where, owing also to an insufficient quantity of oxygen, nutrition and oxidation are deficient, and their life is defectively maintained. Thus both the digestion and absorption of nutriment and oxidation in the tissues are deficient in those in whom the quality of the blood is defective.

The blood-tests were mainly made among the respectable working classes, and in no instances among those in whom there was any suggestion of lack of a sufficient supply of food. Reasons why robust health should be found among these classes, although the supply of food is neither always so much in quantity nor so good in quality, are that with normal blood all the food taken is assimilated, and owing to the fact that, as manual work imposes less strain on the nerves, health can be maintained on food of less nutritious value than in the case of brain-workers with the more highly organized nervous system.

That each individual may have sound health, there must be a sufficiency of food of the necessary constituents; but unless the blood is capable of fulfilling its functions satisfactorily, the food will fail to maintain the effective nutrition of the tissues, and when it is of the best quality and of the most suitable constituents, the normal oxygen-carrying capacity of the blood is equally a necessity.

The under-feeding of school-children is considered to be an important factor in producing physical deterioration, and so it is in those who are affected; but the results of the blood-tests show that malnutrition, owing to anæmia, causes it far more.

From the result of investigation, Dr. Eicholz estimates that 16 per cent. of the elementary school population of London are underfed.[1]

The tests show that of London boys between seven and fourteen years, only 19 per cent. had blood approaching to that of normal health. In 50 per cent. the hæmoglobin percentage was below 90, and in 31 per cent. it was below 80; in all these the nutrition of the tissues would be defective.

Of the total number of boys of this age in the five centres, only 15 per cent. had blood in a normal physiological condition. In girls of the same age the quality was defective in still large numbers.

Air.

The question of pure air and ventilation has been discussed in relation to physical deterioration,[2] and on studying the physiological function of respiration their importance is clearly seen.

Inspired air contains 4 to 5 per cent. more oxygen and about 4 per cent. less carbonic acid than expired air.

Physiology shows that during the respiratory process oxygen from the air is absorbed by the hæmoglobin contained in the red corpuscles of the blood, and is thus conveyed to the tissues; that, as Sir

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[1] 'Report of the Committee on Physical Deterioration, 1904, p. 66.

[2] *Ibid.*, pp. 20, 56.

M. Foster says, 1 gramme of hæmoglobin can absorb 1·59 c.cm. of oxygen; that the amount of oxygen which is absorbed is not entirely independent of the degree of partial pressure of the oxygen in the air; that 'when the percentage of oxygen in the atmosphere is reduced by decidedly more than half,' 'arterial blood ceases to take up oxygen';[1] and 'that at a high temperature less oxygen is taken up' than would be the case 'at a lower temperature, the partial pressure of oxygen in the atmosphere remaining the same.'[2]

Physiology shows that the escape of carbonic acid from the blood is by diffusion, and in order that this may take place, it is necessary that the pressure of carbonic acid gas in the air of the pulmonary alveoli should be less than the pressure of carbonic acid gas in the pulmonary artery; that there is a respiratory process in the tissues, and that the oxygen, which is necessary for their life, combines in them with other material brought by the blood, oxidation occurs, and the waste product carbonic acid passes into the blood. It is thus seen that essentials for the respiratory process to be efficiently carried on are, that hæmoglobin should be present in the blood in its proper proportion, and that the composition of the air should be normal.

The main objects of ventilation are to allow the entry of pure air, the escape of carbonic acid, the waste product given off by the lungs, and to prevent overheating.

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[1] 'Textbook of Physiology,' part ii., sixth edition, p. 605.

[2] *Ibid.*, p. 602.

The question has been raised whether it is the freshness that makes the air in the country superior to that in towns, as ventilation can be made effective in both. The air in towns must be somewhat vitiated in comparison with that sweeping over the sea or open country; but the physiological fact remains—that, unless the hæmoglobin constituent of the blood is present in its normal percentage, the absorption of the necessary amount of oxygen is impossible, however pure the atmospheric environment may be.

The ventilation of houses and factories may be made efficient, but unless the blood of the individuals concerned is sound, the resulting benefit will be less than should be the case.

Urbanization.

The accumulation of the majority of the population in the large towns has an effect in relation to physical deterioration. It is known that 77 per cent. of the population of England and Wales now live in urban districts, whereas fifty years ago the proportion was 50 per cent.,[1] so that at the present time more than three-quarters of the population live in town centres.

On making a comparison between the blood of boys from seven to fourteen years of age in Norfolk and in Bromley, it is seen that in the latter district a larger number per cent. had a hæmoglobin percentage above 90, and a greater proportion had blood of inferior quality below 80. Also, that the percentage of hæmoglobin in the blood of the women and children in the country district in Yorkshire was less than among the women and children of either London or Bristol.

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[1] 'Report of the Committee on Physical Deterioration,' 1904, p. 16.

Thus, this country area in Yorkshire would not be able to send a population into these cities, owing to the deficient quality of their blood, of as good a physique in many instances as those already in them. Many districts would send a greater number in good health, but observations and blood-tests show that a large percentage of those of both sexes and of all ages entering urban from rural districts have anæmia in various degrees. With defective blood there is a tendency to its still further deterioration on their entry into crowded town centres, and this will account for the larger number of boys with a hæmoglobin percentage below 80 in Bromley than in Norfolk.

The reverse of the existing condition is required in order that the standard of the individual's physique may be maintained, and instead of the deficiency of hæmoglobin, it is all the more necessary, on removing from rural into urban centres, that the blood should be sound, for with increased overcrowding both of houses and of districts, air less pure, and conditions of employment often necessitating more indoor life, the need for the oxygen-carrying capacity of the blood to be normal is greater, in order that, although the atmospheric environment is less favourable, it may still be capable of absorbing the requisite amount of oxygen.

The obtaining of more remunerative employment in towns, and consequently better food, should tend to counteract the effect of less favourable atmospheric conditions, but for the normal nutrition and life of the tissues oxygen must be absorbed in sufficient quantity, and a deficiency of hæmoglobin in the blood of any of those who enter town centres from rural districts will prevent oxidation being effected to the extent necessary for sound health.

With this tendency to deterioration owing to defective blood occurring among persons in urban districts, where the population is large but with no highly congested centres, it can be seen that it must be increased among those who live in slum areas under conditions of overcrowding, less nutritious food, and more vitiated atmospheric environment.

Alcoholism.

The effect of alcohol on the mental and physical health of the individual is a question of which much has been spoken, and with regard to the physique of the population as a whole has an important bearing.[1]

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[1] 'Report of the Committee on Physical Deterioration,' 1904, pp. 30-34.

The abnormal conditions produced by excess in it are well known to pathologists, and there is no doubt that the habit has a deteriorating influence, both mentally and physically, long before a fatal result may be produced, and, inducing such effect in the individual, has in addition a degenerating tendency on the children of whom he or she may be the parent. While not going far into the pathology, impairment of the digestive organs, organic disease of the liver and kidneys, and irritability of the nervous system, are some of the results occasioned by the abuse of alcohol.

That there is excessive drinking in the country is admitted by all observers. The question then arises, Is there any prevalent physical condition that may lead to this?

It has been said that one factor in the prevention or lessening of drinking habits is to raise the moral stability and character of the individual, and it is admitted by many social observers that the standard of health and of physique has an important bearing on morality—that is to say, good health and the self-control which a sound bodily state engenders is a great deterrent to vice of all kinds; and conversely, deteriorated health leads to decrease of self-control, and consequent tendency to vice.

The defective physique which is frequently induced owing to the prevalence of anæmia is, then, a condition that leads to a diminution in self-control, and increases the tendency to immoderate drinking in both men and women.

Whether there is an increase of intemperance among men cannot easily be proved, but that it is more prevalent in women of the working classes has been noticed by many observers.[1]

There are causes which may account for the growth of alcoholism among the female population. One is that during recent years there has been greater employment of women in occupations away from their homes, and other than those of a domestic kind. With the added inducements that work away from the home affords, some give way to excessive drinking.

Such a cause may account for a proportion, but imperfect health induces, I believe, far more to acquire the habit. Owing to their anæmic state, many are debilitated both mentally and physically, and the nature of the employment entailing as it does in many instances considerable exertion, they turn to alcohol to stimulate and counteract the mental and bodily fatigue.

Its intemperate use, far from sustaining the health, has the reverse effect, and, by causing instability of the brain and nervous system, leads in many instances to insanity.

Many who have gone into the question of alcoholism are advocates of total abstinence; others consider that moderation among all classes would bring about the most satisfactory results. Whatever opinion is held, those who are debilitated owing to anæmia are far more liable to suffer from even a limited amount of alcohol; and those who are in a weakened condition from the same cause, and drink in excess, are likely to be affected in a serious manner by the results of it.

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[1] 'Report of the Committee on Physical Deterioration,' 1904, p. 31.

The Conditions under which the Children of the Country Live.

This is a subject of great importance in relation to physical deterioration;[1] for to ensure that the body shall grow and develop from youth to maturity under favourable circumstances is the most certain way of securing a healthy and robust race of men and women.

1. **INFANT MORTALITY.**—The high rate of infant mortality that occurs in both rural and urban, and especially in manufacturing districts, is a question in which the causes are important.

The main cause I believe to be that, owing to the anæmic condition of the blood of the parents—in some cases in the mother, in other instances in the father, and frequently present in both—the vitality imparted to the embryo is low from the time of conception, and when the blood of the mother is deficient in quality, it is unable to supply sufficient nutrition and oxygen to the developing embryo during intra-uterine life. In consequence, at birth, the health of the infant is too defective to allow of its separate existence.

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[1] 'Report of the Committee on Physical Deterioration,' 1904, pp. 44-76.

Overcrowding, the disability for breast-feeding, and the employment of women late in pregnancy and too soon after childbirth, tend to aggravate the main cause.

That large numbers are born of such inferior physique that life is impossible for any length of time, observation and statistics go to prove. Many die within a week, many more within a month of birth; nearly half of the infant mortality occurs within three months of birth, and others die later from the effects of pulmonary and other diseases,[1] from which, owing to their reduced vitality, there is little chance of recovery.

In Sheffield, in 1901, the general rate of infant mortality was 201 per 1,000, going up in one district to 234 per 1,000. In some parts of London the rate reaches 223 per 1,000. In Hanley and Longton and in some Lancashire towns it is still higher.[2]

2. THE EMPLOYMENT OF WOMEN LATE IN PREGNANCY.—This question has been considered with regard to the effect on the offspring, and, affecting to a great extent manufacturing districts in the North of England and in the Potteries, is accounted for by the fact that women are largely employed in factory-work.

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[1] Statistics prepared by Dr. Tatham (Appendix to 'Report of the Committee on Physical Deterioration').

[2] 'Report of the Committee on Physical Deterioration,' 1904 pp. 44, 45.

In districts in the North of England, as in Preston and in the Pottery districts, there is a lack of regular occupations for men, and the women, being able to obtain permanent work, become to a great extent the bread-winners. In such places, therefore, the necessity for their employment when in this condition is mainly economic.[1]

In the life of such a married woman the strain occasioned during pregnancy by the factory-work, the domestic duties at home, and perhaps by the attendance on children, has a tendency to lower the vitality both of the mother and of the embryo; and that the health of both may be maintained at a normal standard, and energy supplied for the factory and home work is only possible, if possible at all, when the mother is of sound physique and has normal blood.

3. **THE DECREASE IN BREAST-FEEDING.**—This is apparent in all parts of the country,[2] and there can be no doubt that a healthy supply of mother's milk is by far the best for the nutrition of the infant.

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[1] 'Report of the Committee on Physical Deterioration,' 1904, pp. 48, 49.

[2] *Ibid.*, pp. 50, 51.

When the mothers have to return to factory employment in a month after the birth of a child, they wish in many instances to avoid breast-feeding; but the decrease is also to be noticed in rural and other centres where the occupation of women away from their homes is comparatively infrequent.

In such districts I have found that the women would, as a rule, prefer to nurse their infants from the breast; but there are reasons why it is not always possible for breast-feeding to be carried on.

On studying the physiological function of the secretion of milk, it is seen that the secreting cells obtain their nutrition from the blood, and that by them the milk is secreted and formed from material conveyed by it.

The tissues of which the mammary gland is composed derive the nutriment and the material which is necessary for their normal growth and development from the blood, and in women who suffered from anæmia during the growing age there is neither a sound condition of the gland-tissues nor of the secreting cells, and in consequence they are unable to perform their functions satisfactorily. In addition, on the birth of the infant, the blood of the mother is defective, both as to its oxygen-carrying capacity, and also owing to the imperfect digestion and absorption of food in nutrient material, and thus the cells are still further deterred from exercising their functions of secreting and forming normal milk in those who have defective blood.

Two imperfect conditions of the mammary gland may be seen in anæmic women. In some in whom the physical development of the body as a whole is defective, the breasts are imperfectly formed, there is little secretion of milk—not sufficient to nourish the infant—and this supply often fails in the course of a few days. In others who are of better physique, the breasts are more developed, there is greater secretion of milk, and it continues, but the quality is deficient, and the infant is unable to obtain enough sustenance from the breast-feeding.

Neither of these conditions would be present in such large numbers if the blood had been normal during the period of their growth and development, and until the birth of the infant; and the cause of the disability of women for breast-feeding may be mainly attributed either to their having been anæmic from childhood, or to the anæmia having been acquired at a later age.

Modified cow's milk is usually considered the best alternative to human milk, but some women, on the breast-supply failing, resort at once to various artificial foods. With regard to this, many require the fact pointed out that it is the best substitute when the mother's milk is inadequate. But the aim should be to prevent the necessity for artificial feeding by restoring the blood to a sound state, and so preventing the debility and the consequent inability of mothers to supply the nutritious milk, which is most efficacious for the infant's healthy growth and development.

4. **THE SCHOOL SYSTEM.**—It has been noticed that, although education is made free for children, and their attendance at school compulsory, yet deteriorating influences are apparent among them in both urban and rural districts.

The blood-tests show the large percentage who are anæmic, and this I believe to be the main cause which prevents the school system being thoroughly satisfactory.

Education imposes a tax on the brain and nerves; physiology shows the former to be a considerable heat-producer, and during the process of exercising its reasoning faculties—that is, during the period of special mental activity—oxidation is increased in it.

In order that the school system may have satisfactory results, both mentally and physically, the necessity is that, at the same time that the brain of the individual child is developed by education, care should be taken that the growth and development of the body does not suffer; for although mental capacity is increased by education, unless the physical condition of the child is maintained, at its completion the corresponding good results will be less than should be the case.

Physiological reasons show that, unless nutrition is maintained in the body as a whole by normal blood, physical development would be retarded by the increased development of the brain.

The energy which is set free by the brain during the educational process is supplied by oxidation, the result being heat and the mental effort, the latter corresponding to the mechanical labour set free by muscular and other tissues.

In anæmia the blood is incapable of absorbing the normal quantity of oxygen, and in consequence the energy which the body as a whole is able to generate is deficient. If, then, such energy as the body can produce is used to a great extent in the special development of the brain, it will develop at the expense of the physical development, which is partially arrested. But although in this case the latter suffers as the result of the former, neither the brain nor the body develops normally, and the capacity for sustained mental and physical effort is always defective in those who have anæmic blood.

On the other hand, when the blood is sound, and is thus capable of absorbing the normal quantity of oxygen, the energy set free in the tissues is sufficient for the development both of the brain and of the body, provided that neither the mental nor physical endurance of the individual is overtaxed.

5. **ADOLESCENCE.**—The period between the end of school life—at the age of fourteen among the working classes—and the growth of the individual until manhood or womanhood is reached is a time of import-

ance in physical development, and has been discussed with regard to the risks of deteriorating influences during that period.[1]

The observation has been made that many girls, especially in manufacturing districts, do not mature at such an early age as should normally be the case, and that at the ages of eighteen and twenty there is often a defect in the development of the body as a whole. Dr. Eicholz, quoting the secretaries of girls' clubs with regard to their physique, says that 'as soon as a girl leaves school she does not fall off immediately, but between fifteen and seventeen she begins to suffer.'[2]

This condition is no doubt more prevalent in manufacturing centres, but is noticeable in all parts of the country. Among domestic servants it is of common occurrence; after varying periods many return home, being unfit to continue their employment.

The main cause of the failure in health may be ascribed to the fact that—as the tests show—the blood of a large percentage of girls during the school age is anæmic in various degrees.

With this condition of the blood, and consequently debilitated system, at once on leaving school in many manufacturing centres, or shortly after in other districts, they commence employment entailing many hours a day of indoor work, and it is being done at a time of life when the growth and development of the body is particularly active.

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[1] 'Report of the Committee on Physical Deterioration,' 1904, pp. 72-76.

[2] 'Minutes of Evidence on Physical Deterioration,' 1904, p. 32.

Owing to the anæmia and to the nature of their occupation, which to such must often be arduous, many soon begin to suffer still further in health. If they keep on with their employment in this condition there is a partial arrest of growth, and at the age of eighteen or twenty, instead of the mature development that should be present, there is a deterioration, especially in those instances where the work has been hard.

The case is different in those who have lived during the early years of childhood, and until the end of school life at the age of fourteen, with their bodies well nourished by sound blood. They then begin work in health, and although it may be trying to the system, unless it is of too laborious a nature, there are no injurious effects. That all girls should have the same standard of physique is, of course, impossible—home surroundings, the food-supply, and other influences tend to make a difference; but to give the individual girl the best opportunity of normal growth and development under those conditions in which she may be placed is to ensure that the blood is restored to, and maintained in, a healthy state. The appearance of girls with normal blood is also that of health, and instead of the pale face, the decayed teeth, and the ill-developed appearance often seen, the reverse is the case, and there is colour in the cheeks, the teeth are sound, and their bodies are well developed.

In the male, that health should be maintained between the age of fourteen and that of adult life is important, and during this period growth and development actively proceed. The blood-tests indicate the large numbers of boys who have anæmia during school ages, and observation goes to show that in both urban and rural districts many live from boyhood to manhood with defective blood, and this I believe to be the main cause of such lack of normal growth and development as is to be noticed among the youth of the country.

On leaving school at the age of fourteen and commencing employment, those with anæmic blood are in a defective physical state; the debility tends to increase, and under the hard work the muscles develop ineffectively, growth is retarded, the teeth decay, and frequently, owing to the relaxed condition of the tissues, flat-foot and other defects make their appearance. Such results are often encouraged by the unfavourable surroundings in which the work is carried on, as in high temperatures, or in an atmosphere laden with dust.

As in the case of girls, to begin employment in health and with a well-developed body due to having lived from an early age with a sound blood-supply, gives the boy the best chance of normal growth and development under those circumstances in which he may be placed, and by restoring the blood, if reduced by the effects of any illness he may acquire during this period, health may be maintained.

All active exercise during leisure intervals, in games, or as members of the Auxiliary Forces, will also tend to counteract conditions unfavourable to efficient development, and at the same time strengthen and invigorate the system.

Insanity.

Whether insanity is increasing in proportion to the population in England is difficult to say; in Ireland there appears to be an increase.[1]

With regard to affections of the brain, anything that retards the healthy growth and development of the individual, both mentally and physically, induces results which predispose to insanity. Thus the effect produced by anæmia may be, and is, I believe, the main predisposing cause of mental break-down in many instances.

Dr. Cabot says: 'The association of anæmia with insanity is too frequent to be a mere coincidence, though it is hard to make either serve as a cause for the other.'[2]

This connection may be ascribed to the fact that, owing to the anæmic state of the blood, the brain and nervous system suffer from defective nutrition and oxidation, in consequence of which their vitality and stability are lowered, and there is a tendency to break-down under the various influences which induce insanity.

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[1] 'Report of the Committee on Physical Deterioration,' 1904, pp. 78-81.

[2] 'Clinical Examination of the Blood,' fifth edition, p. 390.

The self-control which accompanies sound health is also less in those who are anæmic, and, consequently, individuals are more liable to acquire habits which lead to excess in alcohol and to syphilis, two conditions that are known to lead to insanity in a large proportion of cases.

Those who inherit a predisposition to insanity, and are also anæmic, are still more likely to become insane, and various exciting causes will produce mental break-down in them more often and in a shorter space of time than in those who, although hereditarily predisposed, have lived and developed with normal blood.

Over-fatigue.

This may be considered in relation to physical deterioration. It is one of the causes of injury to health, but is also one of the results of defects in it.

Fatigue may be defined as that condition brought about by the expenditure of energy. The energy with which a healthy man begins the day, whether in business or in some active outdoor exercise, may be compared with the fatigue, whether in mind or body, with which he ends the day. Fatigue is common to all animal life, and whereas it is a normal state, being the result of the exercise of the functions of the tissues of the brain and of the body, over-fatigue is abnormal.

Over-fatigue may be defined as the fatigue which is experienced over and above that which should normally be the case as the result of so much labour.

The cause of over-fatigue can be accounted for physiologically. The energy of the body is derived from the oxidation of food into urea, carbonic acid, and water. Food and oxygen, then, are the necessities for the production of energy, and if either is reduced it will be lessened. When, therefore, the blood is defective in hæmoglobin, and in consequence is incapable of absorbing the normal quantity of oxygen, oxidation is insufficient and energy deficient. If less energy is produced there is less for expenditure, and fatigue will be experienced at an earlier period, and over and above that which would be the case if the normal amount had been set free.

Fatigue affects the tissues of the brain in the same way that it does those of the rest of the body. The brain-fag experienced by children and others is over-fatigue of the brain, fatigue being experienced, owing to the inadequate amount of energy produced in it, in excess of that which should normally be the case as the result of the mental effort.

Anæmia is, I believe, the main cause of over-fatigue. The observation has been made in factory employment that women are more affected by it than men.[1] The blood-tests show that anæmia is more prevalent, and in a greater degree, among women than men; therefore oxidation is more deficient, less energy is produced, and consequently over-fatigue is experienced to a greater degree.

Structural Deficiencies.

Although there are at present no great anatomical deficiencies to be noticed in the bony structures of the body in the inhabitants of England, there are signs that they are gradually and almost imperceptibly making their appearance. I shall only refer to those noticed in the jaws and in the size of the female pelvis. The shortening of the jaws has been noticed by Dr. Cunningham and others, and is considered, by causing overcrowding of the teeth, to be one of the predisposing causes of caries.

With regard to the female pelvis, a defective growth in the bones there concerned has been noticed, and the Anthropometric Report of the Committee of the British Association of 1883 drew attention to the question in these words: 'It would appear therefore that the physical (and most probably the mental) proportions of a race, and their uniformity within certain limits, are largely dependent upon the size of the female pelvis, which acts as a gauge as it were of the race, and eliminates the largest infants, especially those with large heads (and presumably more brains) by preventing their survival at birth.'[1]

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[1] 'Report of the Committee on Physical Deterioration,' 1904, p. 28.

Anæmia will, I believe, mainly account for such want of normal growth and development as has been noticed in the bony structures of the body.

The bones, as in the case of all the tissues, are dependent during intra-uterine life on the supply of oxygen and nutrient material derived from the maternal blood. If, then, the blood of the mother is defective, the growth and development of the embryonic bones will be retarded. The imperfections thus begun in the fœtus are continued in infants whose blood is not restored to a normal state after birth.

The blood-tests show that many children of school ages are anæmic, and those who, during fœtal life, received malnutrition from the mother, and after birth have lived and developed with blood which is deficient in its nutritive and oxygen-carrying capacity, are such in whom a shortening of the jaws or a lack of normal growth and development of the pelvic bones would occur.

Education has been suggested as a cause of these conditions to some extent. This affects the bones in the same way that it does the rest of the tissues; and in those who have anæmic blood, if the deficient amount of oxygen, and, consequently, of energy produced in the body, is used to a great extent in the special development of the brain, that of the bones and of the other tissues will be partially arrested. On the other hand, in those who derived normal nutrition from the mother during intra-uterine life and after birth have had sound blood, sufficient energy is set free for the efficient growth and development of the brain, the bones, and of other structures in the body.

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[1] 'Minutes of Evidence on Physical Deterioration,' 1904, p. 98.

CHAPTER VII.

THE PREVENTION OF PHYSICAL DETERIORATION.

Certain social and economic conditions, as well as the influence of environment, produce effects which tend to cause mental and physical deterioration; but observations and blood-tests go to show that the deficient quality of the blood present in a large proportion of the inhabitants of the country is the chief defect which requires to be remedied.

The question, then, mainly resolves itself into the necessity that when the individual's blood is anæmic, it should be restored by the aid of medicine to a healthy state.

The medicinal remedy is existing, and the effect of iron in renewing the oxygen-carrying constituent of the blood can be proved by the hæmoglobinometer; it has the action of a specific for the purpose, and on this account may be considered one of the most valuable drugs to be found in the pharmacopœia and used in the practice of medicine.

Medicinal Methods.

The method of restoring the quality of the individual's blood can now be gone into, beginning with that of pregnant women.

In pregnancy the constitution of the mother has to be taken into consideration, and no sudden endeavour to relieve the anæmia should in any case be attempted, the indication being to gradually restore the blood by medicinal means; and the earlier that treatment is commenced, the better for the mother and the developing embryo.

Small doses of iron are preferable during the period; constipation is then more likely to be avoided, also any over-stimulation that might tend to induce premature birth.

The administration of 5 grains of the ammonio-citrate of iron and 5 minims of glycerine in water two or three times a day, and in cases where anæmia is considerable a grain or two less, is a suitable dose. In a pregnant woman with a hæmoglobin percentage, for instance, at 70, the 5-grain doses, if acting well, may be continued; in some cases 5 minims of the liquor ferri perchloridi may be given twice or three times a day. This dose is usually sufficient in pregnancy, and should rarely be exceeded. The gradual restoration of the blood is the object, and the treatment should be discontinued occasionally for a few days, and then renewed again. With rest, abstinence from alcohol, and freedom from excitement of any sort, the blood of the pregnant woman can be increased in quality to the benefit both of the mother and of the embryo, and with the prospect, in many instances, of a healthy supply of milk for the infant after birth.

In the treatment of anæmic conditions during pregnancy certain reservations must be made. It should not be commenced in women who are employed in occupations—as, for instance, in factory work—away from their homes. During the treatment rest is essential, and in the case of married women not occupied away from home this can usually be taken. Treatment also should not, as a rule, be entered upon during the last two months of pregnancy; but when the anæmia is of a severe degree, and its relief is thought necessary to some extent, it is best for the patient to remain in bed as long as iron is administered.

Anæmia in the mother after the birth of the infant can now be considered. In cases in which the breasts are well developed, and the secretion of milk is sufficient in quantity, but defective in quality, there is usually restlessness and a good deal of crying out on the part of the child. For the first week or ten days after birth it is not usually advisable to give iron to the mother, some additional modified cow's milk being given to the infant in the meanwhile. The requirement is to add to the quality of the milk by increasing that of the mother's blood, and at the end of a week or ten days 5 minims of the liquor ferri perchloridi can be given twice a day; in other cases the ammonio-citrate of iron can be commenced with. Considerable benefit may often be gained from this treatment—the mother's health is improved, sufficient nutrition is shortly derived from the breast-feeding, any extra cow's milk becomes unnecessary, the restlessness ceases, and the infant relapses into the condition of sleep, which is normal at this early age for the greater part of the twenty-four hours.

In those instances in which the breasts are not well developed, and are almost deficient in the secretion of milk, it is not possible to produce a supply of nutritious milk by iron treatment; the child may then be fed on modified cow's milk, but the mother should, at the end of a week or ten days, have the ammonio-citrate or perchloride mixture.

With regard to the infant, the indication is to improve the health by increasing the quality—when defective—of the mother's milk, but when there is marked anæmia, iron may be given in medicinal form. It is better not to begin treatment with iron too early in life, but, when needed, it is of great benefit. At six weeks it is well taken, and after the age of three months borne still better. The dose must be small, and the best effects are obtained with the ammonio-citrate. At the age of six weeks 6 grains of this preparation, and 1 drachm of glycerine in 2 ounces of water, of which a teaspoonful should be given two or three times a day, and at three months 10 grains contained in the mixture, and a teaspoonful taken two or three times a day, are sufficient doses to begin with. The iron should be continued, with a few days of intermission from treatment occasionally, until the hæmoglobin is restored to its normal proportion in the blood. Constipation rarely occurs in infants with small doses, but if present castor oil or compound rhubarb powder generally gives relief. Powders containing mercury should not be administered unless specially indicated.

Children below seven years take iron well, and constipation is the exception. The best results are procured with the ammonio-citrate, the dose being varied according to the age and constitution. Small doses of the perchloride of iron suit some children at five or six, but as a general rule, until seven years of age the former preparation is most useful.

When restoring the blood of children three things are especially necessary—exemption from school-work, good food, and open-air exercise. The foremost is particularly beneficial; the brain, the nervous system, and all the tissues need to be gradually restored to an efficient state by means of increasing the quality of the blood, and with freedom for mind and body, both regain their tone and healthy vitality more satisfactorily.

By seven years, and before beginning the more exacting stage of education at that age, it is necessary that the hæmoglobin should be at the proper percentage, and with the sound health which normal blood ensures, the child will be in a position to benefit by the increased educational requirements. The natural tendency of children to take pleasure in exercise and games will also be maintained, and the efficient growth and development of the body will proceed with the increasing development of the mental faculties.

During the school age, from seven to fourteen years, the hæmoglobin can be renewed by the same method, and, as with younger children when under treatment, freedom from school-work is advisable, also open-air exercise and nutritious food. The ammonio-citrate of iron is the better preparation to begin with, the dose being regulated according to the age and constitution of the child; later, the perchloride can be given, and continued until the normal amount of hæmoglobin is regained.

Arsenic in small doses is sometimes needed when complications exist in addition to the anæmia—as, for instance, in various neuroses; and when iron fails to relieve these conditions proportionately with the increase in general health, liquor arsenicalis may be combined with it.

By these methods and preparations of iron hæmoglobin may be restored in the blood of the great majority of the children of the country, and the further deterioration of their physique which is going on owing to anæmia be thus largely prevented.

In persons between the ages of fourteen and twenty-one the hæmoglobin can be renewed by the same method and preparations of iron, and, as in all stages of anæmia, rest, fresh air, and good food are necessary. In both sexes the treatment should be continued until the hæmoglobin is restored to its proper percentage in the blood. During the period from the termination of education—at the age of fourteen among the working classes — until maturity, the sound health which normal blood ensures gives those of both sexes the best opportunity of developing favourably, and of resisting such tendencies as the circumstances under which they live may have to physical deterioration.

From the age of twenty-one to forty years the hæmoglobin can be restored in the blood with great benefit to health. Those who have lived under favourable circumstances, as with regard to occupation which has not overtaxed the mental or physical health, and with habits of moderation which have imposed no special strain on vital organs, have the prospect of deriving the greatest advantage from the restoration.

During this period treatment should be commenced with small doses of iron, as described under anæmia; for although older, an individual who has been living, in some cases for many years, with defective blood, and in consequence with lowered vitality of the tissues of the body as a whole, cannot be subjected to large doses. The attainment of health is gradual, both on account of the fact that hæmoglobin is only slowly renewed, and that a normal state of the tissues is regained by means of the nutrition derived from the increased quality of the blood.

After forty years the restoration of hæmoglobin can be achieved with good results to the health, and at this age the state of the constitution, and the conditions and habits under which life has been passed, make a difference in the advantages to be gained by it. After forty iron is less likely to be well tolerated than before this age; at the same time, in those who are free from organic disease the renewal may be beneficially effected in many instances.

In those who have lived to this age with sound blood, and in whom some illness has induced anæmia, the restoration can be accomplished with great advantage; and it may be said, as a rule, that individuals who have lived with healthy blood, and have been accustomed to iron medicinally when needed, will tolerate it better than those at this age who have lived with blood deficient in quality, and not previously in their life been habituated to its medicinal use. In old people, as there is a degeneration of the tissues, so the blood deteriorates in quality; but these remarks apply more particularly to those still in the vigour of life. After forty years the same method should be adopted of beginning treatment with small doses.

Having gone into the medicinal methods for the prevention of physical deterioration by restoring the individual's blood, other provisions which prevent such tendencies as there are to deterioration can now be considered.

Food.

The question of food resolves itself into the necessity that for sound health each individual should have a sufficient quantity, of good quality, and of suitable constituents.

This is to some extent an economic problem ; the condition of trade is concerned, and the possibility of the breadwinners being able to obtain employment that will secure means to procure the food which is required to maintain the individual and those who are dependent on such in health.

It is said that there is a distaste for domestic duties in some British housewives, but with the sound health that normal blood ensures, both mentally and physically, the wives and mothers of the working classes would bring more intelligence to bear on the subject, and would not be found wanting either in the desire or the capability of supplying the well-prepared food which is needed by the individuals who rely on them to provide this necessity of life, instructed and aided as they often are by various philanthropic societies.

In factory and other districts it has been noticed that the young girls and women do not always supply themselves with those foods the constituents of which are most conducive to health. This can be largely accounted for by the defective physical state many are in owing to anæmia, in which it may be considered a symptom to prefer a diet composed mainly of substances—as sweets and pastry—of the carbohydrate class rather than the more strengthening and sustaining food that comes into the class of proteids. The decay of the teeth and the gastric affections, which are frequently associated with anæmia, also lead to their securing unsuitable food.

With normal blood and good health, and the teeth and digestive organs consequently sound, the procuring of nutritious food by young women would be more probable, and its digestion would be possible.

The underfeeding of school-children has been previously considered, and the blood-tests show that the number of those who are underfed, even at the highest estimate, is far less than those who have blood which is deficient in the oxygen-carrying constituent. So it is at all ages and in both sexes: unless sufficient oxygen is absorbed, the nutrition of the various tissues of the body will be defective, and the tendency which good food has to prevent deterioration will be partially ineffective.

Ventilation.

The obtaining of pure air in houses, schools, factories, and under all those circumstances of indoor life which various occupations necessitate, is a question that is being increasingly considered and remedied, and efficient ventilation will prevent the deteriorating effects the otherwise vitiated air would have; but all such measures will fail to accomplish their full purpose unless hæmoglobin is present in the blood in the normal amount.

Urbanization.

This is chiefly due to the increase of occupations in the towns and their decrease in rural districts; and however great an advantage it may be to the health of individuals, and especially to the growth and development of children, to live in the purer air of the country and in an environment of less restraint, where the employment is, there, within easy distance, must the parents' home be situated.

Anæmia is prevalent in London, and that this should be the case is only what would be expected from the state of the inhabitants of the rest of England, for it is well known that the Capital—and the same applies to other large cities—yearly receives a large influx of persons who were born and brought up in rural districts; and those who have lived in an environment more conducive to the development of a sound physique are relied on to a great extent to maintain the standard of robust health.

How important, then, is the necessity that those brought up in country surroundings, both for the health of the rural population and for the upkeep of the physique of the residents of London and other large cities, should on reaching the age of manhood and womanhood be in health. Almost every town and village in England sends members of its community to the Metropolis, and if all of them, as well as those from Scotland, Ireland, and Wales, were in good health, they would be sufficient to supply fresh vigorous life; for even with the improvement that would be effected in the physique of the inhabitants of London by renewing the quality of their blood, the maintenance of a healthy population will always require the influx of those with sound minds and robust bodies from less congested areas.

To prevent such tendency as city life may have to physical deterioration, the main necessity is that the blood of individuals should be normal, so that, although the atmospheric environment is less favourable, it may still be capable of absorbing that amount of oxygen which is needed for the nutrition and life of the tissues. With the blood of those living in town centres restored to a healthy state, and with the influx into them of persons of robust physique from country districts, any tendency that urbanization may have to physical deterioration should be to a great extent prevented.

Alcoholism.

In order to prevent the degeneration which arises from excessive drinking, a great factor would be to advance the mental and physical condition of individuals, by renewing the quality of their blood, and the increased self-control that accompanies good health will then prevent the tendency of many to acquire the habit. The intemperance induced in the attempt to relieve the debility caused by anæmia will also be largely eliminated.

Infant Mortality.

The greatest agency in the prevention of infant mortality is health on the part of the parents, and if both have lived their life with sound blood, this will ensure it in the majority of instances. The child will then be robust at birth, and the mother capable of supplying milk sufficient in quantity, and of good quality.

The restoration of the blood of infants when anæmic both gives them an increased opportunity of satisfactory growth and development, and adds to their prospect of successfully resisting the attack of any disease they may acquire.

If for economic reasons the employment of women late in pregnancy is a necessity, an important influence in preventing any deterioration which certain occupations at this time may cause in the mother or the embryo, is a normal blood supply on the part of the former.

Games and Exercises.

The effect these have in the physical development of school-children and in the prevention of deterioration may be gone into from the physiological point of view.

In order that games and exercises may produce their full beneficial results, and that the adequate growth of the body may continue with mental development by education, the essential is that the blood should be in a healthy state.

If the blood is deficient and the brain is specially developed, physical development will be deterred ; and conversely, if the blood is defective and physical development is particularly sought by means of games and exercises, mental development will suffer.

In anæmia the energy set free by the body as a whole, in consequence of deficient oxidation, is insufficient for effective development both mentally and physically, and with special attention to physical improvement, mental development is partially arrested. On the other hand, with sound blood the necessary energy is set free for efficient physical and mental development to go on at the same time.

A necessity, then, in order that games and exercises may have the effect of preventing deterioration and of improving the physique, is that the blood should contain the proper quantity of hæmoglobin, and so be capable of absorbing and conveying to the tissues that supply of oxygen which is needed for the production of the normal amount of energy.

Insanity.

A great preventive of insanity would be the restoration to, and maintenance of the blood of individuals in, an effectual condition.

The increased self-control which health induces will then prevent many from acquiring habits of excess that lead to insanity, and in persons with well-nourished tissues, both of the brain and of the body, the various exciting causes will produce less effect than in those whose vitality is lowered owing to anæmia.

The instability of the nervous system and consequent predisposition to insanity is hereditary, and in order to prevent those who inherit this tendency from becoming insane, certain precautions are advisable.

Individuals who are hereditarily predisposed are such in whom discretion in the use of alcohol is especially necessary. In most instances it is better to abstain altogether, and in any case spirits should not be taken.

The stimulating effect produced by alcohol should, as a rule, be avoided. The inherited nervous instability, which may be lessened by maintaining the body in a well-nourished condition, is especially liable to be excited into such a state as to become beyond the control of the individual; and an amount of alcohol that has apparently no deteriorating effect on a healthy person will in many instances in a short space of time cause complete mental break-down in those who inherit the predisposition.

It is also especially necessary that the brain and nervous system should not be overtaxed by education, and although it may be proceeded with, on any sign of mental overstrain making its appearance, a period of rest should be taken.

On making a selection of occupation, it is evident that one which makes no special demand on the capacity of the brain would be such that would be least likely to induce insanity.

With these precautions with regard to alcohol, education, and occupation, and also by maintaining the health of the tissues by ensuring a normal blood-supply, it is possible that the inherited predisposition to insanity may be prevented from taking effect in the individual; and with the same precautions in the children of such, that any instability of the nervous system derived from parental sources may be greatly reduced, and in succeeding generations altogether eradicated.

Immigration

Various other measures for the prevention of physical deterioration have been discussed, and immigration is considered to have an influence in maintaining the physique of the population. Many years before the fall of Rome this was regarded as an important factor in preserving the vitality of the nation.

In 'The History of the Decline and Fall of the Roman Empire' (E. Gibbon), this fact is brought forward in the following words: 'The narrow policy of preserving, without any foreign mixture, the pure blood of the ancient citizens, had checked the fortune, and hastened the ruin, of Athens and Sparta. The aspiring genius of Rome sacrificed vanity to ambition, and deemed it more prudent, as well as honourable, to adopt virtue and merit for her own, wheresoever they were found, among slaves or strangers, enemies or barbarians.'[1]

Many causes contributed to bring about the fall of Rome, and this policy, although it may have been advantageous, did not prevent it.

To stop the influx of suitable and healthy individuals of other nationalities, with certain exceptions—as, for instance, in the United States and in Australia there are restrictions with respect to the entry of those engaged for contract-work, and in some countries with regard to the ingress of Asiatics and those of the coloured races—is not the policy of modern highly civilized nations. But while the maintenance of the physique of the population of a country may be partially effected by immigration, it is mainly to be brought about by adopting measures to maintain the healthy vigour of those who are indigenous to it, the majority of whom, in the case of England, possess physical characteristics derived from Anglo-Saxon parentage.

An example of the great progress in medical science since the period of the height of Roman power, is shown by the fact that the treatise in which Harvey announced his discovery of the circulation of the blood was published in the year 1628, and was thus subsequent to it.

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[1] Vol. i., chap. ii.

Owing to the advances made, the present generation is placed in a different position, and by the practical application of the principles of physiology and medicine it is possible to renew the vitality of the blood, and by this means to ensure the individual's health in most instances. With the restoration of the blood, and with continued advancement in the social, economic, and hygienic conditions under which the inhabitants live, not only should deterioration be eliminated, but an improvement may be effected both mentally and physically in the population of the country as a whole.

CHAPTER VIII.

ARMY RECRUITING.

The question of obtaining suitable recruits, and the large number of rejections of those wishing to join the army on account of defective physique, has been prominently before the War Office for some time.

Sir W. Taylor, late Director-General, Army Medical Service, prepared a Memorandum on this subject in which the following particulars occur:[1]

From information given in the Reports of the Army Medical Department and of the Inspector-General of Recruiting during a period of ten years, from 1893 to 1902, it was found that 37·6 per cent. of the applicants were rejected by the medical officers.

In addition to these, a number are turned away by the recruiting officers or recruiting sergeants, and Sir F. Maurice has formed the opinion that 60 per cent. of the men who apply for enlistment are rejected as physically unfit for service in the army. Sir W. Taylor is unable to say whether 60 per cent. of rejections is reached, but remarks: 'A very large proportion (but probably not quite three out of five as stated by General Maurice) of the men who wish to join the army prove physically unfit for military service.'

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[1] Appendix to 'Report of the Committee on Physical Deterioration.'

In all occupations, whether that of labourers, artisans, mechanics, clerks and shopmen, or professional, there is a high percentage of rejections.

On examining the causes of rejection by the medical officers in the year 1902 with the ratio per 1,000 of the applicants, it is seen that:

Under chest measurement ...	caused	56·72	rejections.
Defective vision	„	39·23	„
Under weight	„	21·72	„
Under height	„	11·59	„
Imperfect constitution and debility	„	3·91	„
Disease of veins	„	12·30	„
Disease of heart	„	17·33	„
Defects of lower extremities...	„	12·27	„
Varicocele	„	12·59	„
Flat feet	„	12·44	„
Loss or decay of teeth ...	„	49·26	„

The last cause is on the increase: in the year 1891, '10·88 were rejected per 1,000' for defects of the teeth.

This Memorandum shows that large numbers of those who desire to become soldiers are found to be unfit for army life.

The causes of rejection indicate that, with the exception of disease of the heart, the majority of them were not due to serious organic affections; and although a proportion which are ascribed to 'under chest measurement,' 'under weight,' 'under height,' and 'defects of lower extremities,' may have been induced by some constitutional disease, as tuberculosis or rickets, the number was so small that any special classification under such a head was unnecessary.

They appear to make evident that there is some influence at work, which prevents the normal growth and development of the male population among the classes under consideration, so that, on reaching the age suitable for enlistment, a large percentage fail to reach the standard of physique which is required for military service.

The question then arises, What is thus tending to retard the sound physical development of many of the male population?

The main cause I believe to be that, owing to the anæmic state of the blood, and the consequent want of normal nutrition and oxidation, the growth and development of the various tissues, and of the body as a whole, has been deficient.

A large number of infants are born defectively developed, owing to one or both parents having had anæmia. Many live from childhood with anæmic blood, and in consequence, on arriving at adult ages do not possess the physical efficiency which is necessary for an army career. In some, owing to the malnutrition, there is under chest measurement, under weight, under height, or imperfect constitution and debility. In others, although development may be better, as a result of the relaxation of the muscular and other tissues, various diseases are acquired, as varicose veins, varicocele, flat-foot; or a yielding of the sclerotic coat of the eye occurs, causing myopia. In others, the defective nutrition of the teeth predisposes to their decay.

Flat-Foot.

This is due to a yielding of the ligamentous and muscular structures in the sole of the foot, which, when in their normal condition, maintain the arch.

As the deformity progresses, the bones lose their correct position on the inner side of the foot, the head of the astragalus projects, the anterior part of the foot becomes everted, and the inner side, losing the arch, is flattened.

Debility is known to be a predisposing cause of the affection, and it frequently comes on in growing boys when their occupation is of such a nature that it excites the constitutional defect. Long standing and carrying heavy weights are exciting causes, but when the ligamentous and muscular structures in the sole of the foot are in health, they have little effect. On the other hand, when these structures are ill nourished and developed, owing to the inefficiency of the blood, the strain put on them incidental to the nature of the employment may cause them to yield, with resulting inconvenience in various degrees. Rheumatism, rickets, and other diseases predispose to flat-foot, but the main cause of the predisposition may be attributed to anæmia.

Owing to the necessity that there should be fitness for marching, drilling, and active exercises, those in whom flat-feet occur are unsuited for an army career.

Disease of Veins.

Varicose veins account for a percentage of rejections, and the occurrence of them may be traced in many instances to the malnutrition of the coats of the veins, and of the muscles with which they are connected in their course. Defective nutrition of the structure of the heart also induces a lessening of the vis a tergo, and so impedes the circulation.

The physiology of the venous circulation shows the importance of the muscular system being in a normal state. Dr. Halliburton observes: 'The effect of muscular pressure upon the circulation may be thus explained. When pressure is applied to any part of a vein and the current of blood in it is obstructed, the portion behind the seat of pressure becomes swollen and distended as far back as the next pair of valves, which are in consequence closed. Thus, whatever force is exercised by the pressure of the muscles on the veins is distributed partly in pressing the blood onwards in the proper course of the circulation, and partly in pressing it backwards and closing the valves behind. The circulation might lose as much as it gains by such an action, if it were not for the numerous communications which the veins make with one another; through these, the closing up of the venous channel by the backward pressure is prevented from being any serious hindrance to the circulation, since the blood, the onward course of which is arrested by the closed valves, can at once pass through some anastomosing channel, and proceed on its way by another vein. Thus, the effect of muscular pressure upon veins which have valves is turned almost entirely to the advantage of the circulation.'[1]

Causes which produce obstruction to the venous circulation from the lower extremities towards the heart may induce varicose veins of the legs at all ages, but in men at recruiting ages the main factors in their occurrence may be attributed to a yielding of the venous walls, and inefficient action in muscles external to them, aggravated by occupations necessitating long standing and severe exertion.

The yielding of the venous walls and the defective muscular action can both be traced to these structures being weak and wanting in tone, owing to the deficient nutrition they have received from the blood. The lack of constitutional vigour in the individual thus shows itself in the varicose condition of the veins.

I have noticed various degrees of varicosity in the veins of the legs on many occasions in young adults who are anæmic, and the result of treatment further indicates their connection with the debility present. When associated with anæmia, I have found, under treatment by iron, and in some cases iron and arsenic, that at the same time the blood and the nutrition of the individual are restored the veins regain their health, and this in some cases when eczema has been present in consequence of the varicosity. Necessarily for such treatment to be effective it must be commenced before atrophy of the valves or organic changes have occurred in the coats of the veins.

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[1] 'Handbook of Physiology,' sixth edition, p. 296.

The fatigue and pain which varicose veins occasion, and the possibility of their rupture, unfit those in whom they occur for a military life.

Varicocele.

This causes a percentage of rejections. Sir F. Treves says it 'is an affection of puberty and young manhood,' and that in 80 per cent. it is 'first noticed before the thirty-fifth year.'[1]

It usually occurs in those who are debilitated, and is a varicose condition of the pampiniform plexus of veins which ascend in the cord in front of the vas deferens. Its causation may be mainly attributed to the defective nutrition, owing to the anæmic state of the individual's blood, of the venous walls and of the muscular structures with which they are associated in their course, aggravated by their dependent position, length, and tortuosity.

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[1] 'A System of Surgery,' 1898, vol. ii., p. 1002.

A lax and pendulous scrotum is usually present, the normal contraction of the rugæ being absent. Support is given to the testicle by the cremaster muscle, and in the dartos of the scrotum there are unstriped muscular fibres; but when, owing to the deficient nutrition derived from the blood, these structures are weakened, the support and the assistance they should afford to the circulation in the veins of the pampiniform plexus are lessened. The spermatic veins within the abdomen also suffer from the malnutrition of their coats, and the aid given to the circulation in them by muscular action is reduced.

The reason for varicocele being more often seen on the left side than on the right is generally considered to be due to the spermatic vein being longer, the pressure of accumulated fæces in the sigmoid flexure of the colon, and to the left vein opening into the renal vein at a right angle.

Sir F. Treves suggests another cause, that of 'the greater force and frequency of the contraction of the muscles of the left half of the abdomen in right-handed persons.'[1]

Normally, active exercise aids the venous circulation in the legs; but when the veins become dilated and the varicose condition begins, the dependent position of the legs and muscular exertion further increase the varicosity. Similarly, when the veins of the pampiniform plexus become distended and varicocele commences, the more dependent position of the left vein, owing to the greater length of the spermatic cord, and the increased muscular action 'of the left half of the abdomen in right-handed persons,' may tend, in addition to the other causes, to its more frequent occurrence on the left side.

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[1] 'A System of Surgery,' 1898, vol. ii., p. 1003.

The aching pain varicocele gives rise to, which is increased by long standing and marching, and the risk of rupture from external injury unfit those in whom it occurs for military service.

The blood-tests in boys from the age of seven to fourteen years show the large numbers who have anæmia: only 15 per cent. had a hæmoglobin percentage approaching to normal—that is, 90 to 100—in 57 per cent. it was 80 to 90, and in 28 per cent. 70 to 80.

Those boys with a hæmoglobin percentage below 80 do not possess blood of the oxygen-carrying capacity that is necessary for sound health.

The 57 per cent. with a hæmoglobin percentage of 80 to 90 also have defective blood, and their development would be retarded.

The blood-tests show that of boys of fifteen, sixteen, and seventeen years, 30 per cent. had a hæmoglobin percentage of 90 to 100; in the remaining 70 it was 80 to 90. Although with increasing age a higher percentage of hæmoglobin is found in a proportion of boys, to have lived to fourteen years with anæmic blood will have retarded efficient growth and development, which cannot subsequently be recovered. In addition, two diseases at least, which are causes of rejection—myopia and the decay of teeth—are already present in many instances before fourteen.

The recruiting age is eighteen to twenty years, but General Borrett says that 80 per cent. of the men enlist at eighteen or nineteen.[1]

With, then, only 15 per cent. of boys up to fourteen years of age, and only 30 per cent. up to seventeen, having blood approximating to a normal state, the rejections may well reach to 60 per cent.

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[1] 'Minutes of Evidence on Physical Deterioration,' 1894, p. 11.

CHAPTER IX.

PREVALENT DISEASES AND THE BLOOD.

ANÆMIA is secondary to a number of diseases. There can be little doubt, also, that the defective vitality of the tissues induced by an anæmic condition of the blood predisposes them to various affections.

The Decay of Teeth.

The prevalence of the decay of teeth has been much noticed, and is considered by Dr. Cunningham and others to be on the increase.

There has been in recent years a larger number of rejections of those who wish to join the army from this cause.

In the 'Minutes of Evidence on Physical Deterioration,' the following statement is made with regard to two schools in Edinburgh: 'It was found that the ratio of defective permanent teeth per 1,000 children was 158·2 in the school for the children of the well-to-do working people, and 273·9 in that for the children of a better class, professional men and merchants.'[1]

Sir J. Tomes says the examination of the teeth of 480 boys of an average age of fourteen years, on board the *Exmouth* training ship, showed that '24 per cent. had perfect teeth, 44·9 per cent. had from one to four permanent teeth carious, 22·9 per cent. had from five to eight, and 5·25 per cent. had more than eight carious permanent teeth.'[1]

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[1] P. 280.

The development of all the temporary and also of all the permanent teeth, with the exception of the eight back molars, commences at an early period in intra-uterine life. Of the eight back permanent molar teeth, the papilla of the second makes its appearance about the sixth month after birth, and the papilla of the third about the fifth year.

DENTINE.—The pulp contained in the cavity inside a tooth is the remains of the papilla, and it is by columnar-shaped cells of mesoblastic origin called odontoblasts which cover the latter, that the dentine is developed and calcified, the necessary material for their nutrition and for the development and calcification of the dentinal substance during intra-uterine life being derived from the maternal blood.

The pulp is made up of blood-vessels and nerves, which enter it through an aperture at the end of each fang, loose connective tissue, and cells. Some of the cells permeate the connective tissue, and others line the pulp cavity adjacent to the dentine. These latter cells are the odontoblasts, and they have two processes, one of which, called Tomes's fibre, enters a dentinal tubule; the other communicates with the connective tissue of the pulp.

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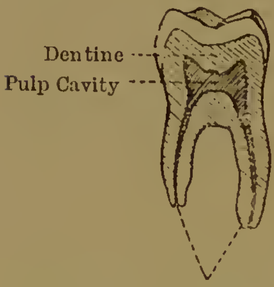
[1] 'Dental Surgery' (edit. C. S. Tomes), fourth edition, p. 249.

Dentine is composed of animal and earthy matter, 'the proportion in a hundred parts being about twenty-eight animal to seventy-two of earthy.' 'The earthy matter is made up chiefly of calcium phosphate, with a small portion of the carbonate, and traces of calcium fluoride and magnesium phosphate.' The animal matter 'may be resolved into gelatine by boiling' (Kirke).[1] In construction dentine is made up of dental tubuli and intertubular tissue.



Apertures for entry of blood-vessels and nerves. (After Buchanan.)

Dr. Halliburton observes: 'The tubules of the dentine, the average diameter of which at their inner and larger extremity is $\frac{1}{4500}$ of an inch, contain fine prolongations from the tooth-pulp, which give the dentine a certain faint sensitiveness under ordinary circumstances, and without doubt have to do with its nutrition. These prolongations from the tooth-pulp are processes of the dentine cells or odontoblasts, the columnar cells lining the pulp cavity; the relation of these processes to the tubules in which they lie is precisely similar to that of the processes of the bone-corpuscles to the canaliculi of bone.'[2]

Gray says: 'The dentinal fibres are analogous to the soft contents of the canaliculi of bone.'[3]

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[1] 'Handbook of Physiology,' thirteenth edition, p. 78.

[2] 'Handbook of Physiology,' sixth edition, p. 69.

[3] Gray's 'Anatomy, Descriptive and Surgical,' fifteenth edition, p. 858.

It seems evident this is the way dentine is supplied with nutriment, the lymph that transudes from the blood-vessels in the pulp being conveyed to it by means of these columnar cells and their processes, in a similar manner to that in which lymph from the Haversian blood-vessels in bone is transmitted by the bone-corpuscles and their processes, situated in the lacunæ and canaliculi, to its substance.

ENAMEL.—Enamel is developed by cells of epiblastic origin, named ameloblasts or adamantoblasts,[1] which derive their nutrition and the necessary material for its development and calcification during intra-uterine life from the maternal blood.

It is the hardest substance in the body, and, according to Kirke, in construction is made up of hexagonal fibres radiating from the dentine towards the surface of the tooth, which are bound together by hyaline cement substance, and in composition is of the same chemical constituents as dentine and bone.

Whatever the exact consistency may be, in any case it contains a considerably less amount of animal matter. Kirke gives 2 to 3 per cent. as the proportion;[2] Bibra found 3·5 per cent.;[3] Mr. Tomes concludes from the result of experiment 'that there is no organic matter at all (in any noteworthy amount) in enamel.'[1]

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[1] C. S. Tomes, 'Dental Anatomy,' sixth edition, p. 159.

[2] 'Handbook of Physiology,' thirteenth edition, p. 79.

[3] Gray's 'Anatomy, Descriptive and Surgical,' fifteenth edition, p. 859.

It is not proposed to go at any length into what has hitherto been considered the constitution of enamel, and opinions now held, but some reference to the question is necessary.

Mr. Tomes says that enamel is 'to be regarded as an inorganic substance composed of lime-salts which have been formed and deposited in particular patterns under the influence of organic tissues, which have themselves disappeared during its formation.'[2]

With regard to 'the ultimate constitution of enamel, Mr. Leon Williams' states that: 'The entire mass becomes so completely calcified that in normal mature enamel there is left no trace of organic matter. Only the original form remains duplicated in mineral substances like a fossil' (Tomes).[3]

Bödecker considers 'that enamel is built up of columns of calcified substance, between which minute spaces exist filled by a material' of a protoplasmic nature, and 'continuous with the soft contents of the dentinal tubes.'[4]

While not admitting that the interstitial material is protoplasmic in character, Klein remarks that 'the enamel cells, like all epithelial cells, being separated from one another by a homogeneous interstitial substance, it is clear that the remains of this substance must occur also between the enamel prisms; in the enamel of a developing tooth the interstitial substance is larger in amount than in the fully formed organ' (Tomes).[1]

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[1] 'Dental Anatomy,' sixth edition, p. 13.

[2] *Ibid.*, p. 14. [3] *Ibid.*, p. 26. [4] *Ibid.*, p. 27.

It thus appears that opinions differ as to the exact composition of enamel in its fully developed condition. Sir J. Tomes and other authors draw particular attention to the effect various affections have in predisposing to caries of the enamel equally with the dentine, and it is difficult to conceive how constitutional diseases can have any influence on a substance devoid of living animal matter. The buccal secretions also would have no more action on such a structure than in the case of added dentures.

Taking the view of Kirke and others that, although, owing to the necessity for its hardness, enamel contains less organic matter than either dentine or bone, yet is still a living substance, it therefore requires, as a physiological necessity, similarly to other tissues and cells of epiblastic origin in the body, material derived from the blood, both for efficient growth and development, and subsequently for the maintenance of its normal nutrition.

Mr. Tomes observes that in man dentinal tubes have occasionally been seen to enter the enamel;[2] and 'between the enamel fibres, near their dentinal surface,' there are many minute lacunæ, which Gray says are 'a provision calculated to allow of the

[1] 'Dental Anatomy,' sixth edition, p. 30.

[2] *Ibid.*

permeation of fluids from the dentinal tubule into the substance of the enamel.'[1]

With regard to the manner in which the nutrition is effected, it is probable that lymph is conveyed through the dentinal tubule to the enamel, and then, as Gray says, penetrates into its structure.

CRUSTA PETROSA.—The crusta petrosa, which covers the fangs of the teeth, is composed of true bone, but only contains Haversian canals in the thickest part. The canaliculi have been observed to sometimes communicate, as Kirke and Gray say, with the outer ends of the dental tubuli. In this way nutriment can be conveyed to the dentine from a source in addition to and unconnected with that obtained from the pulp.

THE CAUSE OF CARIES.—The exciting cause of caries is considered to be acids which are formed in the mouth by fermentation and putrefaction; these dissolve the enamel, and micro-organisms then entering through the breach effect a disintegration of the dentine.

The predisposing causes may be divided into those connected with the mouth and the jaws, defects in the composition and structure of the teeth, and constitutional causes.

1. In the mouth anything which induces a diseased condition of the mucous membrane tends to produce caries.

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[1] Gray's 'Anatomy, Descriptive and Surgical,' fifteenth edition, p. 858.

In the jaws lack of development predisposes by causing overcrowding of the teeth, and in consequence a retention of acid and decomposing products between them.

2. With regard to deficiencies in the composition and structure of the teeth, Sir J. Tomes remarks: These 'may be of two kinds; the dental tissues may be otherwise well-formed of good stout material, and yet have defects of form which make vulnerable points, or the whole of the dental tissues may be of such material that they have little power of resistance to adverse influences,' and 'minute deep fissures may be extended through the enamel to within a short distance of the dentine.'[1] He also speaks of poor quality and non-resistant teeth.[2]

Mr. Sewill observes: 'Ill-made tissues—enamel or dentine—imperfectly calcified throughout or in part, constitute one of the main predisposing causes of caries.'[3]

3. Constitutional diseases are considered important as predisposing causes of caries. Sir J. Tomes has noticed caries to be common in anæmic females; that it occurs also in fevers; and states that during a case of rheumatic fever almost every tooth was attacked.

Mr. Sewill says acute caries is associated with general ill-health. 'A very common example is seen in patients the subjects of long-standing chlorosis.'[4]

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[1] 'Dental Surgery,' fourth edition, p. 193.

[2] *Ibid.*, p. 196.

[3] 'Dental Surgery,' fourth edition, p. 192.

[4] *Ibid.*, p. 252.

The constitutional affection that most frequently predisposes to caries may be ascribed to an anæmic condition of the mother's blood, causing a deficient supply of material for the growth and development of the teeth which occurs during intra-uterine life, and after birth to anæmia in the individual.

Although the material for the development of the teeth in fœtal life is derived from the mother, the vitality imparted by the father has an influence on them, as on other tissues and structures of the body, and when both parents have anæmic blood the predisposition is still greater.

The decay of teeth may, I believe, be mainly attributed to the following:

The predisposition may be commenced during intra-uterine life, when the mother's blood is anæmic, both on account of the fact that the nutrition of the cells concerned in their development and calcification is inefficient, as a result of which they are incapable of fulfilling their normal functions, and that the maternal blood-supply is deficient in the material which is necessary for the effective growth of the teeth.

The quality of the constituents and their further development after birth will also be defective in those who have anæmic blood.

The enamel may thus be imperfectly formed, and sometimes has fissures leading down to the dentine. The enamel and dentine may also be too soft and non-resistant.

In consequence the acids formed in the mouth by fermentation and putrefaction dissolve the softened enamel, micro-organisms then enter the dentine through the breach, and a cavity is caused by its disintegration and the dissolving of the carious matter. In this way caries is produced in the temporary teeth.

The permanent teeth are affected in the same way: in those in which development begins during intra-uterine life, the predisposition may be commenced during this period, and in such a child if the blood is not restored after birth, their further growth will be defective.

The eight molar teeth, whose development is not begun until after birth, will also be deficient in quality, and predisposed to caries in individuals who have anæmic blood.

The shortening of the jaws which causes overcrowding of the teeth has been previously gone into.

Thus ineffective nutrition during intra-uterine life, a predisposition obtained through the father, or imperfections derived from both parents, in combination with an anæmic condition after birth, will account for the predisposition to caries in many cases.

In other instances the tendency may be due to deficiencies in nutrition caused by acquired anæmia, although it has been normal during intra-uterine life and there are no inherited parental defects.

Certain observations also point to the association of caries with anæmia. Sir J. Tomes has observed it more often among females; the blood-tests show that anæmia is more prevalent in the female sex. Anæmia is of frequent occurrence in servants, and Mr. Dolamore has noticed the prevalence of caries among them.[1]

In Lancashire I found anæmia to be specially evident, and caries is much seen. Mr. Dolamore says that in Lancashire districts the condition of the teeth is very bad.[2]

THE PREVENTION OF CARIES.—Owing to the part taken by the teeth in the mastication of food, and to the necessity that it should be thoroughly triturated, in order that digestion may be normally effected in the stomach and intestines, the prevention of caries becomes of considerable importance to the individual's health. Anæmia, in consequence of the predisposition to which it gives rise, will, I believe, mainly account for its prevalence.

By restoring to, then, and maintaining the blood of men and women in a healthy state, such predisposition to caries as is commenced owing to anæmia in the parents may be prevented.

Similarly, after birth, by restoring to and maintaining the individual's blood in a sound condition, the occurrence of the decay of the teeth may be largely diminished.

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[1] 'Minutes of Evidence on Physical Deterioration,' 1904, p. 280.

[2] *Ibid.*, p. 282.

Diseases of the Stomach

The various forms of dyspepsia and gastritis have been classed in different manners, but the arrangement mainly resolves itself into those conditions either of an acute or chronic nature. In this way Dr. Osler classifies these diseases. Thus, under the description of acute gastritis is included simple gastritis, acute gastric catarrh, and acute dyspepsia; and under that of chronic gastritis is comprised chronic catarrh and chronic dyspepsia.

The prevalence of gastric affections, both acute and chronic, is evident in all localities, and their causation may be mainly attributed to anæmia.

As anæmia occurs in various degrees, so also do indigestion and dyspepsia.

In considering gastric diseases, it has to be remembered that digestion and absorption are only partially effected in the stomach, but also continue in the intestinal canal, more especially in the small intestine. Defects of nutrition which diminish the functions of the stomach and predispose to disease of it will, then, also lessen those of the small and large intestines, and thus the emaciation which occurs in chronic gastritis is due both to the deficient digestion and absorption in the stomach, and also in the intestinal canal.

ACUTE GASTRITIS.—There are various exciting causes, as insufficiently masticated food, errors in diet, the abuse of alcohol, exposure to wet and cold, and, as Bristowe says, constitutional debility. Dr. Cabot says acute gastritis does not affect the red cells or hæmoglobin. This is only what would be expected, as the attack does not continue for a sufficient length of time to have an appreciable effect on the blood-corpuscles.

That anæmia predisposes to acute gastritis I have noticed on many occasions, the following instance being an example. A young woman, aged twenty-two, the wife of a farmer, acquired the complaint, with the usual symptoms of vomiting, headache, pain in the epigastrium, and in this case associated with fainting. There was no account of any errors or excess in diet, but general health had not been good for some time. The patient had no organic disease. The hæmoglobin was estimated, and the percentage found to be 70. With this degree of anæmia the secretions would be defective, the vitality of the coats of the stomach, as of other structures in the body reduced, and the predisposing cause of the attack may be ascribed to it.

CHRONIC GASTRITIS.—Chronic dyspepsia unconnected with organic lesions may be occasioned by a variety of causes, among which are an excess or deficiency of the gastric juice, defects in its composition—as, for instance, in the amount oı hydrochloric acid, or of pepsin—or an enfeebled state of the walls of the stomach. Various diseases also induce the condition, as gout, the infectious fevers, tuberculosis, and any affection producing low vitality in the tissues.

Dr. Cabot says anæmia is very frequently present, and may be in a severe degree.[1]

The cells and the different tissues which constitute the stomach may be pathologically affected. The cells may 'show cloudy granular swelling,' or are partly eroded, or atrophy (Osler).[2] Sometimes there is a fibrous overgrowth of the connective tissue between the glands, the bundles of muscle fibres, and in the submucous coat; while the tubes lose their regular form, become cystic, or disappear. In some of the most chronic cases the gastric walls are thickened, the muscular fibres waste, or the mucous membrane is completely atrophied.

It is thus seen that chronic gastritis, commencing as a functional affection induced by defects in the gastric juice, weakness of the coats of the stomach, or both, may as the disease progresses give rise to serious structural lesions.

Anæmia is, I believe, the main cause of the prevalence of the disease, and of the progressive deterioration of the wall of the stomach. This can be well understood from a study of the physiological process of digestion; and on the first onset of gastritis, if the quality of the blood is not restored the tissues, owing to the defective nutrition, still further degenerate, various pathological lesions occur, and in some cases atrophy of the entire mucous membrane is the final result.

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[1] 'Clinical Examination of the Blood,' fifth edition, p. 324.

[2] 'The Principles and Practice of Medicine,' sixth edition, p. 460.

I have observed the association of anæmia with chronic gastritis in various cases, and the following will serve as an illustration.

A young woman, aged twenty-six, a nurse by occupation, came under treatment for chronic gastritis; she had been unfit for work for four months. On seeing this patient the tongue was brown, furred, and considerably fissured; there was pain in the epigastrium, emaciation, and constipation, the only diet taken being peptonized milk and a small quantity of light farinaceous food. She had no organic disease. The hæmoglobin was estimated, and the percentage found to be 78.

With blood of this character neither the coats of the stomach nor the secretions would be sound, and the cause of the gastritis may be attributed to anæmia.

Treatment.—In the treatment of gastric affections, after allaying the more acute symptoms, the indication is to restore the various tissues and glands concerned in digestion to a healthy state. When associated with any degree of anæmia, and in the absence of organic disease, this may be effected by renewing the quality of blood by means of iron, the most valuable preparation being the liquor ferri perchloridi.

The principle of giving iron in gastritis conforms to the physiological necessity, which is that, for efficient digestion, the muscular and other structures of the stomach, as well as of the rest of the alimentary canal, and the secretions of the various glands concerned in the digestive process must be in a sound condition. By administering iron the increased nutrition derived from the blood restores these tissues to health, also those of the glands and their cells, which then become capable of secreting and forming normal secretions from the blood. In addition, the tendency to further degeneration of the stomach walls is arrested.

Irritability of the nervous system is frequently present in chronic gastritis, and in these cases arsenic is often needed in addition to the iron, the nerves regaining their health at the same time as the other tissues. In some instances it is not advisable to give arsenic at first on commencing treatment with iron, but when solid food is well taken it may be added.

Quinine is sometimes also of use in the treatment of gastritis, and when the system as a whole is depressed, or there is an indication for its bitter effect, it may be combined with the iron.

Hydrochloric acid is often deficient in amount in the gastric juice, and Dr. Osler says 'it is not only necessary for its own important actions,' but also that 'it is only in the presence of a sufficient quantity that the pepsinogen is converted into the active digestive ferment.'[1] The acid contained in the liquor ferri perchloridi is usually sufficient to supply the deficiency until the secretion is restored to its proper consistency.

Strychnine, as contained in the preparations liquor strychninæ hydrochloratis and tinctura nucis vomicæ, has been advocated to restore the tone of the stomach, but when anæmia is present it is, I believe, seldom needed. Strychnine has the action of a bitter, is a nerve stimulant, and is also considered by some observers to stimulate the contractions of the stomach, and to increase the peristaltic action of the muscular coat of the intestines; but it has no effect in relieving the anæmia with which gastritis is largely associated. With regard to bitter tonics, Dr. Osler remarks: 'Strychnia is the most powerful, though none of them have probably any very great stimulating action on the secretion, and influence rather the appetite than the digestion.'[2]

When anæmic conditions are present the hæmatinic action of iron is indicated, but for such treatment to be effective it must necessarily be commenced before serious organic disease, as atrophy of the glands or mucous membrane, or wasting of the muscular fibres, has occurred; for it is evident that, when such defects are present, remedial measures will fail to restore the coats of the stomach to a healthy state.

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[1] 'The Principles and Practice of Medicine,' sixth edition p. 464.

[2] *Ibid.*, p. 466.

In both the instances described under acute and chronic gastritis, after allaying the immediate symptoms, 5 minims of the liquor ferri perchloridi in glycerine and water was given three times a day after food, and continued until the hæmoglobin was restored to its normal percentage in the blood—above 90.

In the chronic case the administration of a mixture containing bismuth and soda had no action in relieving the state of the tongue or the pain. The results produced by the iron were that the tongue cleared, the fissures healed, and the pain was relieved, and at the end of a fortnight the gastric symptoms had subsided, and a mixed diet containing meat was taken. Treatment was continued, and at the end of five weeks from the commencement of it by iron the patient resumed her occupation.

She was not of the more robust type of constitution, and the increase of weight gave proof of the satisfactory effect of the drug. Before the administration of iron it was 7 stone 6 pounds; when treatment was discontinued it had increased to 8 stone 6 pounds, showing that with the improved digestion there was an advancement in the nutrition of the body as a whole.

ULCER OF THE STOMACH.—This is a disease closely associated with anæmia and chlorosis, as has been noticed by many observers. Dr. Osler says: 'Anæmia and chlorosis predispose strongly to gastric ulcer, particularly in women and in association with menstrual disorders. A very considerable number of all cases of gastric ulcer occur in chlorotic girls.' 'Of 1,699 cases collected from hospital statistics by W. H. Welch and examined post-mortem, 40 per cent. were in males and 60 per cent. were in females.'[1]

Dr. F. Taylor remarks: Gastric ulcer 'is much more frequent in women than in men, in the proportion of 3 to 1; but it seems to be fatal to the sexes in about equal proportion.'[2]

Dr. Cabot says in gastric ulcer severe anæmia is common: 'There is no single disease, so far as I am aware, in which the red cells are apt to be so low, except in pernicious anæmia.' He records that in 51 cases with hæmorrhage, 80 per cent. had a hæmoglobin percentage below 50[3]; and that in 30 cases where there was no hæmorrhage, 8 had a hæmoglobin percentage below 60, 14 a percentage of 60 to 80, 4 a percentage of 80 to 90, and in 4 it was 90.[4]

With regard to the pathology, the view accepted by some authors is that thrombosis occurs in a small vessel, and as a result of cutting off the alkaline blood from the area it supplied, the gastric juice is enabled to dissolve a portion of the mucous membrane. The necrosis that takes place has also been attributed to bacteria. Other causes which have been suggested are injury, scalding food, or the action of chemical irritants.[1]

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[1] 'The Principles and Practice of Medicine,' sixth edition, p. 471.

[2] 'The Practice of Medicine,' fifth edition, p. 609.

[3] 'Clinical Examination of the Blood,' fifth edition, pp. 316-319.

[4] *Ibid.*, p. 320.

Dr. Osler observes that experiments on animals have shown that emboli, and chemical or mechanical agents applied to the mucous membrane, may produce ulcers, and he adds when thus occasioned they rapidly heal, 'unless the animals have been rendered anæmic by repeated abstractions of blood.'[2]

Small superficial ulcers have been noticed in the stomach under various conditions, and Dr. Osler states that they are usually seen 'in connection with chronic gastritis, diseases of the liver, particularly cirrhosis, and chronic diseases of the heart.'[3]

Bristowe considers it not unlikely that these ulcers, which usually soon heal, may not do so in certain instances, and then enlarge, owing to the irritation to which they are subjected.[4]

That emboli may, in some cases, cause gastric ulcer appears to be indicated by its artificial production in this way, but however this may be, the following is, I believe, by far the most frequent cause.

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[1] F. Taylor, 'The Practice of Medicine,' fifth edition, p. 610.

[2] 'The Principles and Practice of Medicine,' fourth edition, p. 480.

[3] *Ibid.*, sixth edition, p. 468.

[4] 'The Theory and Practice of Medicine,' seventh edition, p. 676.

It is more often found in the pyloric region; erosions in connection with chronic gastritis are also more common in this situation, and anæmia is frequently associated with chronic gastritis. If, then, an erosion occurs in the stomach of an individual who is anæmic the exciting cause of which may be injury, or scalding by food, a local inflammatory process is set up, and the constant irritation caused by the movements of the stomach, the acid of the gastric juice, and by food, still further induces its progress. In consequence of the anæmia there is no tendency to heal, and thus, as seen in the case of certain abrasions of the surface of the body, the inflammation extends, and ultimately the ulcer is produced.

Gastric ulcer is more frequent in women than in men. The blood-tests show that anæmia is more prevalent among women, that it is of greater degree, and that 15 per cent. of those whose blood was examined had a hæmoglobin percentage below 70.

The relation between gastric ulcer and the blood is that anæmia predisposes to its formation, is secondary to it, and retards the healing process.

THE PREVENTION OF DYSPEPSIA, GASTRITIS, AND GASTRIC ULCER.—Owing to the necessity that food should be well digested in order that a sound physique may be maintained, the reduction of these diseases becomes of great importance to the health and development of individuals and of the population as a whole.

Their prevalence may, I believe, be mainly attributed to anæmia. By restoring to, then, and maintaining the individual's blood in a normal condition, a healthy state of the digestive tract may, as a rule, be attained, and dyspepsia, gastritis, and gastric ulcer to a large extent prevented.

Myopia.

The sclerotic and the cornea form the external coat of the eyeball, the sclerotic forming the posterior five-sixths of the circumference, the cornea the anterior sixth. Gray says the sclerotic 'is a firm, unyielding, fibrous membrane, serving to maintain the form of the globe ';[1] it 'is formed of white fibrous tissue intermixed with fine elastic fibres, and of flattened connective-tissue corpuscles, some of which are pigmented, contained in cell-spaces between the fibres.' 'Its vessels are not numerous, the capillaries being of small size, uniting at long and wide intervals.'[2]

A yielding of the sclerotic coat of the eye is the main cause of myopia.

Mr. Nettleship remarks: 'Myopia is very rarely present at birth; the elongation of the globe which constitutes myopia comes on gradually during the growing period of life, and especially between the ages of ten and twenty; the eye begins to elongate during childhood. Though myopia is strongly hereditary, it may also begin independently, especially from the prolonged use of the eyes for near work. The strain on the internal recti, counterbalanced, it may be, by a corresponding tension on the external recti, is believed to act by compressing the eyeball, and thus causing the unprotected posterior pole of the sclerotic to bulge.'[1] 'In high degrees of myopia the sclerotic is enlarged in all directions.'[2] He also adds that 'the concomitant tension of the ciliary muscle,' and 'the habit of stooping over the book or work,' probably aid by causing congestion, and thus predispose the coats of the eye to yield.[3]

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[1] Gray's 'Anatomy, Descriptive and Surgical,' fifteenth edition, p. 806.

[2] *Ibid.*, p. 807.

Myopic conditions may progress until atrophy of the choroid of various degrees, opacities in the vitreous, or detachment of the retina occur, and in high degrees the lens may become affected by cataract.

What, then, causes the sclerotic to yield?

Myopia comes on gradually, and at the age of eight, nine, or ten years frequently begins to give trouble. Mr. Nettleship says: 'General enfeeblement of health, as after severe illness or prolonged suckling, seriously increases the risk of its progress, even after middle life.'[4]

Mr. Priestly Smith observes: 'An ill-nourished, pale, and lax condition of body lowers the resisting power of the eye, as of every other organ; . . . an impaired physique brings with it, among other evils, an impaired resistance to the active causes of short sight.'[1] 'It is clear that constitutional disease may be a factor in any case of myopia. It may account for the abnormal yielding of the sclera; it certainly often aggravates the morbid changes in the choroid and retina.'[2]

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[1] 'Diseases of the Eye,' fifth edition, p. 305.

[2] *Ibid.*, p. 300. [3] *Ibid.*, p. 305. [4] *Ibid.*, p. 306.

It is thus seen that constitutional defects are considered an important factor in the causation of the affection.

The main constitutional cause of myopia is, I believe, due to an anæmic state of the blood of one or both parents, of the individual, or of both parents and child.

The sclerotic and the various structures contained in the eye derive their nutriment from the blood, and those parts, as the cornea and the lens, in which there are no capillaries still rely on the lymph for their nutrition. During intra-uterine life, also, the sclerotic is dependent, as are other tissues, on material derived from the mother's blood for its normal growth and development.

It is normally firm and unyielding, and although myopia is rarely present at birth, its tissues will not be in a healthy state in the children of mothers who had anæmic blood during pregnancy. The malnutrition thus begun during intra-uterine life is continued in children whose blood is not restored after birth, and so, aggravated in many instances by the congestion caused by stooping over books, and by the excessive accommodation necessary for continued near work, it gradually yields.

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[1] *British Medical Journal*, January 21, 1905.

[2] *Ibid.*, January 14, 1905.

In the same way, although the sclerotic may be normal at birth, acquired anæmia will, by causing an ill-nourished and relaxed condition of its tissues, predispose to myopia. Mr. Nettleship says: 'It is, however, to be noted that some of the very worst cases occur in persons who have never used their eyes for close observation of any kind.'[1]

In such cases the debility induced by anæmia is especially indicated as being the cause, for without the aggravation produced by congestion or by near work the myopia comes on.

Mr. Priestly Smith examined 1,100 Board-school children, and found that 7·5 per cent. of the girls and 4·5 per cent. of the boys had myopia.[2] The blood-tests show that anæmia is more prevalent in girls than boys, and the higher percentage of myopia among the former may be thus accounted for.

THE PREVENTION OF MYOPIA.—The prevalence of myopia may, I believe, be mainly attributed to anæmia.

By restoring to, then, and maintaining the blood of men and women in a normal state, such tendency to a yielding of the sclerotic as is begun owing to anæmia in the father, or to the defective nutrition derived from the mother owing to the same cause during intra-uterine life, may be prevented.

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[1] 'Diseases of the Eye,' fifth edition, p. 306.

[2] *British Medical Journal*, January 14, 1905.

In like manner, after birth, by restoring to, and maintaining the individual's blood in health, the nutrition of the sclerotic may be sustained, and the occurrence of myopia in many instances thus prevented.

CHAPTER X.

PREVALENT DISEASES AND THE BLOOD—*Continued.*

Tuberculosis—Phthisis.

TUBERCULOSIS and phthisis are the terms used to denote the changes that take place in the tissues as the result of the invasion of them by tubercle, the former referring to those which occur in the structures of the body as a whole, the latter to those found in the lungs.

The prevalence of tuberculosis is a question to which much attention has been directed. Dr. Osler observes: 'In the United States Census Report for 1900 more than 10 per cent. of the deaths were assigned to tuberculosis. It has been estimated that at least 150,000 persons die annually in the United States of some form of the disease. In England and Wales the deaths due to tuberculous disease in 1903 were 58·107, 11·3 per cent. of the total mortality.'[1]

Drs. Fagge and Pye-Smith say with regard to phthisis: 'It is estimated that a third of the deaths between fifteen and forty-five in England is due to this terrible disease.'[1]

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[1] 'The Principles and Practice of Medicine,' sixth edition, p. 285.

The view generally accepted is that for one or more reasons various parts of the body become predisposed to tuberculosis, the exciting cause in all cases being the tubercle bacillus.

An investigation into the causes which induce the bacilli to set up tuberculous lesions in one individual more than in another, and in one tissue more than in another, forms a subject of great interest, for it is generally considered that each individual in a population, such as that of England, among whom tuberculosis is prevalent must from time to time be subjected to their attack.

This becomes evident when the fact is remembered that, as Dr. Osler remarks, 'patients with advanced pulmonary tuberculosis throw off in the expectoration countless millions of the bacilli daily.'[2] If this expectorated matter is voided in any public place, it dries, becomes mixed with the dust, and thus from this one source many individuals may become infected.

THE EXCITING CAUSE.—There are several ways in which the bacilli may gain an entry into the system.

1. **DIRECT INHERITANCE.**—The direct infection of the embryo through either parent is thought to be of rare occurrence, and experiments appear to indicate that infection through the spermatozoa and

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[1] 'A Textbook of Medicine,' fourth edition, vol. ii., p. 37.

[2] 'The Principles and Practice of Medicine,' sixth edition, p. 286.

the ovum may occur, but that, as Dr. Osler observes, 'probably the almost constant method of transmission in congenital tuberculosis is through the blood-current, the tubercle bacilli penetrating by way of the placenta.'[1] Dr. P. Kidd says: 'The only conclusion at present warranted is that direct inheritance is of decidedly subordinate importance to extra-uterine infection, however acquired.'[2]

2. **INOCULATION.**—That the bacilli occasionally gain an entry into the body through cuts, bites, post-mortem, circumcision, and other wounds of the skin is generally held to be the case; but Dr. Osler says: 'It may be said, on the whole, that inoculation in man plays a trifling rôle in the transmission of tuberculosis.'[3]

3. **THE RESPIRATORY SYSTEM.**—Dr. Koch considers that the most frequent way in which the bacilli gain an entry into the system is by inhalation. This is also the view generally accepted by English observers, the medium being infected dust.

4. **THE ALIMENTARY SYSTEM.**—Dr. Koch maintains that it is not proved that human tuberculosis is communicable to man by the bacillus of bovine tuberculosis, through the medium of milk and flesh derived from infected animals.

Although this question is not definitely decided, observers in this country incline to the opposite opinion, and precautions are taken to prevent the sale of milk and meat obtained from those animals which are affected.

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[1] 'The Principles and Practice of Medicine,' sixth edition, p. 288.

[2] Allbutt, 'System of Medicine,' 1898, vol. v., p. 175.

[3] 'The Principles and Practice of Medicine,' sixth edition, p. 290.

After inhalation or ingestion it is said that, when there is a predisposition to tuberculosis, the bacilli lodge in the tissues of the lungs, or in those of the alimentary canal, there causing primary tuberculous lesions, from which foci they may later become disseminated by means of the blood or the lymphatics throughout the body.

Although the bacilli may in many instances thus cause a lesion at the point of entry into the system, in many others I believe this is not the case, but that, after being inhaled or ingested, they pass into the blood through the walls of the capillaries, and are then conveyed to all parts of the body, tubercle only being set up in those tissues which from one or more causes are predisposed to its development.

The bacilli are rod-shaped, and measure, as Dr. F. Taylor remarks, 'about half as much as the diameter of a red corpuscle—and their breadth is about one-sixth of their length.'[1] They consist, as Dr. Whitelegge says, 'of protoplasm enclosed in a cellulose membrane.'[2]

There appear to be no bacteriological, anatomical, or physiological facts to disprove that these minute organisms, after having been inhaled or ingested, would, if not in all cases, under certain circumstances, readily gain an entry into the blood through the walls of the capillaries of the lungs or of the intestines.

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[1] 'The Practice of Medicine,' fifth edition, p. 136.

[2] 'Hygiene and Public Health,' fifth edition, p. 233.

As already stated, it is considered that the bacilli may be conveyed from the mother to the embryo by way of the placenta. If, then, they are capable of penetrating the membranes which separate the maternal from the fœtal blood, they will be able to make their way through the thin walls of the capillaries of the lungs or of the intestines, and in the case of the latter would be as readily absorbed as are the nutrient substances derived from food.

Against this view it may be urged that the epithelial cells of the respiratory and alimentary systems would exercise a selective action and prevent their entry, but this would no more be so than in the case of their lodgment in the pulmonary or intestinal tissues.

The question of whether the epithelial cells of these regions have the power, when in a healthy state, of preventing the entry of the bacilli into the body is undecided, but causes which induce defective nutrition in the tissues will equally affect that of these cells, and thus tend to decrease their normal function; and it is reasonable to suppose that when such has occurred in a sufficient degree, any selective action the epithelial cells may have on the bacilli would be rendered ineffective.

However this may be, if it be maintained that pathological conditions which induce catarrh, abrasion, or epithelial desqüamation of portions of the alimentary or respiratory systems must occur before the bacilli can enter these tissues, then also such effects would facilitate their entry into the capillaries, and without of necessity causing primary lesions at the point of ingress.

Miliary or general tuberculosis occurs as a complication of localized tuberculous affection of the lungs, bones, or other structures, and it has been suggested, as Dr. Osler says, that the determining factor in its occurrence may be the entry of numbers of bacilli into the blood, owing to the perforation of the coats of a blood-vessel by caseous masses situated externally to it.

This form of tubercle is also set up in those in whom no local lesion can be discovered, and who are apparently in their usual health. In such cases the direct entrance of the bacilli into the blood is particularly indicated, for, although they gain admittance into the body by respiration or ingestion at the same time that tuberculous deposits may occur in the tissues of the lungs and of the liver, others more distant, as those of the kidneys, membranes of the brain, and of other structures, may be affected.

It thus seems evident that the bacilli enter the system in such a way that they are suddenly transferred by some common medium to all parts of it, and there appears to be no method of entry more probable than that of their direct passage into the blood through the walls of the capillaries.

Tuberculous disease of bones frequently occurs when there are no symptoms of any other structure being affected, and this also points to the direct entry of the bacilli into the blood, in which they are conveyed, to set up lesions in those which for various reasons are predisposed.

It is considered by some observers that, if human tuberculosis is acquired through the medium of milk derived from infected cows, primary disease of the intestines should be of more frequent occurrence; but, assuming that in many instances the bacilli first enter the blood and are then dispersed throughout the body, although they may gain an entry through the capillaries of the intestines, if the tissues of the lungs only are predisposed, they will show the primary lesion.

Thus, although the lungs are the most frequent seat of primary tuberculous affection, the bacilli may in some instances have entered the system by another channel than that of the respiratory tract.

Similarly, although the bacilli may have passed into the body through the lungs, if the tissues of the intestines, of a bone, or of another structure only are predisposed, such will show the primary lesion.

The proportion in whom primary tuberculous disease of the intestines occurs has been variously estimated, but that it is of comparatively infrequent occurrence, although the bacilli may have entered the body by ingestion, may be attributed to there being a greater susceptibility to the attack of the bacilli on the part of the tissues of the lungs, bones, and of other structures than of those of the intestines.

Secondary affection of the intestines is of common occurrence in phthisis, and that such is the case appears to indicate that, although they are not especially liable to primary lesions, when their vitality has become lowered owing to the effect produced by the disease as it occurs in the lungs, they then become predisposed, the particles of sputum which are swallowed bringing the bacilli into direct contact with these tissues.

Whether or not it is frequently the case that tubercle is acquired through the medium of food derived from infected animals, there are ways in which the bacilli of human tuberculosis may be introduced into the intestines. For instance, a servant or other inmate of a house who has phthisis and inhabits kitchens, larders, or rooms where food is kept or prepared for consumption, may cause the dust in these places to become infected with bacilli, which may then settle into milk, on to butter, or on to cooked meat, and thus they may gain an entry into the intestines of those who partake of them.

The Predisposing Causes.

1. **GEOGRAPHY AND CLIMATE.** — Tuberculosis occurs among the inhabitants of all parts of the world, and its prevalence is not influenced to any great extent by latitude or climate. In high regions

its occurrence is less frequent, but it is considered that the scarcity of the population partly accounts for this feature in its distribution.

Dr. Osler observes: 'The disease is perhaps more prevalent in the temperate regions than in the tropics, but altitude is a more potent factor than latitude; in the high regions of the Alps and Andes and in the central plateau of Mexico the death-rate from tuberculosis is very low.'[1]

Dr. Kidd remarks: 'But while the evidence negatives the opinion that hot climates favour phthisis, all authors are agreed that the disease in tropical countries assumes a more acute and virulent type.'[2]

2. **RACE.**—Tuberculosis attacks those of all races. Dr. Osler says that the death-rate from this cause among the North American Indians and negroes is higher than among the whites; that the Irish in America have a very high death-rate; but that the influence of race 'is probably not due to any inherent differences but to the conditions under which the individuals live.'[3]

3. **ENVIRONMENT.**—The view that various influences which adversely affect the environment tend to lower the vitality of the individual and predispose to tuberculosis is generally accepted. Thus, those who live under unfavourable hygienic conditions,

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[1] 'The Principles and Practice of Medicine,' sixth edition, p. 285.

[2] Allbutt, 'System of Medicine,' 1898, vol. v., p. 157.

[3] 'The Principles and Practice of Medicine,' sixth edition, p. 285.

among which may be enumerated a deficiency of food, air, or sunlight, and overcrowding, are more prone to its development.

4. **HEREDITY.**—The view which is generally accepted is that, although in rare instances infants are born with tubercle, it is not the disease itself which is inherited, but a tendency on the part of the tissues to its occurrence. The proportion in whom the hereditary predisposition can be traced in phthisis is usually considered to be about 30 per cent.

5. **SEX AND AGE.**—In those of both sexes and of all ages there appears to be no difference in the death-rate from tuberculous affections generally. The deaths from phthisis, also, among those of all ages shows almost an equal percentage in the sexes; but when a comparison is made of the mortality, it is seen that at certain ages there is a considerable difference in the proportion of deaths.

Dr. Kidd quotes passages from a statistical account prepared by Dr. W. Ogle, formerly Registrar-General, with regard to the death-rate from phthisis, in which the following particulars occur:

During the first two years of life the male rate is higher than the female; but, taking the first five years together, the rate is nearly the same, 'the male being only very slightly higher.' From five to thirty-five years of age the female rate of mortality is considerably above that of the male, and especially between the ages of ten and twenty, when it is 50 per cent. higher. After thirty-five until the end of life the male rate of mortality exceeds the female.[1]

The proportion of infants and children in whom tubercle occurs has been variously estimated, and Drs. Ashby and Wright consider that statistics are of little value, owing to 'the impossibility of diagnosing tuberculosis of the internal organs, especially in the milder forms.'[2]

In statistical tables prepared by Dr. Tatham 4 to 5 per cent. of the deaths of infants under the age of twelve months, during the years 1898 to 1902, were attributed to tuberculous diseases.[3]

Dr. Osler remarks: 'The mortality from tuberculosis in the first years of life is relatively high. Of 2·576 autopsies made on children, 27·8 per cent. who died in the first year were tuberculous (Boty). Of 182 autopsies on children one year or under, seventeen were tuberculous (Comby).'[4]

6. **OCCUPATION.**—Sedentary occupations are usually considered to predispose to phthisis, partly owing to the fact that they are often carried on in rooms and workshops which are defectively ventilated, devoid of sunlight, and where the accumulation of bacilli is likely to occur, and partly that in many instances a deficient amount of open-air exercise is taken.

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[1] Allbutt, 'System of Medicine,' 1898, vol. v., pp. 160, 161.

[2] 'The Diseases of Children,' fifth edition, p. 246.

[3] Appendix to 'Report of the Committee on Physical Deterioration,' 1904.

[4] 'The Principles and Practice of Medicine,' sixth edition p. 288.

It is also thought that occupations which are associated with dust, as tool-grinding, pottery-work, mining, needle-polishing, and others tend to induce phthisis. It is well known that pathological lesions of the lungs occur among such workers, but whether they are usually of a tuberculous nature is not decided. Dr. Kidd observes: 'This much, however, is certain, that pulmonary affections in persons following dusty occupations, if not always in the first instance tuberculous, are very liable to become so; the chronic inflammation of the bronchi and lung being favourable to the development of this infection.'[1]

7. **INDIVIDUAL.**—Certain types of constitution described as the tuberculous and the scrofulous have been said to predispose to tuberculosis. Dr. Osler says with regard to them: 'These conditions, on which so much stress was formerly laid, indicate, as Fagge states, nothing more than delicacy of constitution, incomplete growth, and imperfect development.'[2]

Various diseases also are known to be the precursors of phthisis, among which are diabetes, measles, whooping-cough, influenza, small-pox, bronchitis, syphilis, typhoid fever, malignant disease, cirrhosis of the liver, rheumatism, chlorosis, dyspepsia, chronic heart disease, and chronic nephritis.

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[1] Allbutt, 'System of Medicine,' 1898, vol. v., p. 159.

[2] Mitchell Bruce, 'Materia Medica and Therapeutics,' 1899, p. 293.

The Blood.

In describing the effect of tuberculosis on the blood, Dr. Cabot writes: 'Even in advanced stages the count of red cells is often normal, or increased, with correspondingly high hæmoglobin.' 'In a smaller number of cases the hæmoglobin is much diminished, although the count of red cells is normal.' 'In a small percentage of cases both red cells and hæmoglobin are considerably diminished, the latter usually suffering more than do the actual number of cells, that is, the colour index is usually below 1.'[1]

At first sight it thus appears that tubercle in some instances has no influence on the number of red corpuscles and the amount of hæmoglobin in the blood, but on going into the question more fully it is seen that the effect is always considerable.

Dr. Cabot remarks: 'Maragliano and others have shown that during fever from any cause a contraction of the peripheral vessels occurs.' 'The contraction of the vessels causes a concentration of the blood with rise in specific gravity and in the number of blood cells per cubic millimetre. This concentration is still further increased by the greater loss of water which the organism suffers during fever than under normal conditions.'[2]

Bristowe says: 'Hectic fever and gradual emaciation are by far the most important and striking of the general phenomena of phthisis.'[1] Night-sweats are also of common occurrence in phthisis, and, varying in intensity, they are often profuse.

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[1] 'Clinical Examination of the Blood,' fifth edition, p. 289.

[2] *Ibid.*, p. 186.

In phthisis, then, the fever and loss of water which cause a concentration of the blood are usually present, and, in addition to the night-sweats, there is frequently a further drain of fluid when diarrhœa occurs, or an exudation into the peritoneal cavity in cases of tuberculous peritonitis.

These concentrating effects of tuberculosis no doubt account for the fact that, on examining a drop of blood, there is in some instances no diminution in the number of red corpuscles or in the percentage of hæmoglobin.

In phthisis loss of weight is one of the most constant symptoms, and although it is most marked in chronic cases, it is, in acute types, as Dr. Kidd says, 'never entirely absent.'[2]

Physiology shows that the quantity of blood bears a definite proportion to the body-weight, and in tuberculosis the former becomes reduced at the same time that loss of weight occurs in the system as a whole. The blood-forming organs also suffer with the rest of the tissues, both as to their weight and nutrition, and become incapable of forming red corpuscles in sufficient number or of normal quality.

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[1] 'The Theory and Practice of Medicine,' seventh edition, p. 444.

[2] Allbutt, 'System of Medicine,' 1898, vol. v., p. 200.

Dr. Cabot shows in tables the effect that is produced on the red corpuscles by various tuberculous affections. In 'average hospital cases of phthisis' it was found, from a count of the red corpuscles in 67 patients, that the blood of 17 contained 5,000,000 to 6,000,000 per cubic millimetre, 27 contained 4,0000,000 to 5,000,000, 22 contained 3,000,000 to 4,000,000, and 1 contained 2,000,000 to 3,000,000.

The estimation of hæmoglobin in 132 patients showed that 5 had a percentage of 90 to 100, 19 a percentage of 80 to 90, 38 a percentage of 70 to 80, in 35 it was 60 to 70, and in 35 below 60.[1]

In 'acute miliary tuberculosis' the estimation of hæmoglobin in 21 patients showed that 3 had a percentage of 90 or above, 6 a percentage of 80 to 90, 3 a percentage of 70 to 80, in 3 it was 60 to 70, and in 6 below 60.[2]

In 'tuberculous peritonitis' the estimation of hæmoglobin in 28 patients showed that none had a percentage of 90 or above, 3 a percentage of 80 to 90, 6 a percentage of 70 to 80, in 5 it was 60 to 70, and in 14 below 60.[3]

In 'tuberculous meningitis' the estimation of hæmoglobin in 18 patients showed that 3 had a percentage of 90 or above, 6 a percentage of 80 to 90, in 4 it was 70 to 80, and in 5 below 70.[4]

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[1] 'Clinical Examination of the Blood,' fifth edition, p. 292.

[2] *Ibid.*, p. 298.

[3] *Ibid.*, p. 301.

[4] *Ibid.*, p. 303.

From the foregoing it is seen that observations have proved that tubercle occurs in every part of the world and in all climates; that it attacks those of all races and of all ages; and although satisfactory hygienic environment is considered to be a great factor in lessening its occurrence, that in England, where much has been done to improve the conditions under which the inhabitants live, it is still answerable for a large number of deaths.

The question then arises, Is there any constitutional affection prevalent among the population which predisposes many to tuberculosis ?

While it is evident that an individual may be exposed to more than one predisposing cause at the same time, that which mainly accounts for its prevalence I believe to be the reduced vitality of the system which occurs owing to anæmia.

That lowered vitality of the tissues is a potent factor in predisposing to tuberculosis is admitted by all authors, and there can be nothing more likely to produce this effect to a greater extent than that the blood on which they depend for their nutrition and life should be of defective quality.

Bristowe says : 'There is no doubt that conditions which produce deterioration of the general health tend ultimately to induce tuberculosis.'[1]

Dr. F. Roberts observes : 'The tendency to tubercle is certainly more marked in persons of a feeble physical constitution, apart from any obvious special tubercular or scrofulous habit.'[1]

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[1] 'The Theory and Practice of Medicine,' seventh edition, p. 435.

Dr. F. Taylor remarks: 'A disposition to phthisis may be acquired by any circumstance, or combination of circumstances, which seriously lowers the vitality of the body, whether this be a deficient supply of food and fresh air, or prolonged debilitating illnesses.'[2]

The so-called scrofulous and tuberculous types of constitution which are considered to predispose to tuberculosis, and to indicate, as Fagge says, 'delicacy of constitution, incomplete growth, and imperfect development,' can be mainly accounted for by such persons having lived and developed with their blood in an anæmic condition.

Heredity is a subject that has been gone into by various authors, and any detailed account will not be attempted; but, in addition to inherited facial features, in some instances strikingly pronounced, in others less so, the tissues derive certain characteristics from the parents.

That such is frequently the case in bony and muscular development can be verified by all; but an investigation into the causes of those minute variations in the structure and composition of the cellular elements of the body, which must to a large extent account for the inherited predisposition to disease, presents an extensive field for research.

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[1] 'The Theory and Practice of Medicine,' tenth edition, vol. i., p. 366.

[2] 'The Practice of Medicine,' fifth edition, p. 453.

In the case of tuberculosis the inherited tendency may be largely accounted for by the defective nutrition of the spermatozoa, or of the ovum, or of both, owing to the anæmic state of the blood of one or both parents, in some cases caused by tubercle, in others altogether unconnected with it.

That there may be an inherited predisposition although neither parent was affected with the disease is supported by observations of Bristowe, who says: 'Parents themselves seemingly healthy, or at all events free from tubercle, not infrequently beget a family of children who die one after the other of pulmonary phthisis.' This he attributes 'either to the transmission of a taint which is latent as regards the parent, or to the fact that one or other of the parents is scrofulous or syphilitic, or in some other way impaired in health.'[1]

Although tuberculosis is rarely present at birth, the predisposition may thus be congenital. The effect on the vitality of the embryo caused by anæmia in the father, and in the mother during intra-uterine life, has been previously gone into, and the main cause of the congenital tendency to tubercle can be accounted for by the blood of one or of both parents having been anæmic.

Tuberculosis is prevalent among infants and children, and the main cause of the predisposition can be traced to anæmia and the consequent lowered vitality of the tissues, which, in many instances, is begun during intra-uterine life, and is continued after birth in those whose blood is not restored to a sound condition.

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[1] 'The Theory and Practice of Medicine,' seventh edition, p. 435.

The connection between anæmia and phthisis is especially indicated when comparing the rate of mortality from the latter in the sexes at certain ages.

Between the age of five and thirty-five years, and especially between ten and twenty, the female death-rate, as shown by Dr. Ogle's tables, is higher than the male. The blood-tests of those of both sexes at various ages show that anæmia is more prevalent and in greater degree among females than males. During the period from ten to twenty years the same condition occurs, as seen below, and this I believe to be the main cause of the greater prevalence of phthisis in females than males between the ages of five and thirty-five.

Hæmoglobin was estimated in those of both sexes between the age of ten and twenty years in the centres in London, Bristol, Bucks, Yorkshire, and Oxford, with the exception that in the latter centre no tests were made of the blood of girls or young women.

Of males of this age 23 per cent. had a hæmoglobin percentage of 90 to 100; in 58 per cent. it was 80 to 90; and in 19 per cent. 70 to 80.

The average hæmoglobin percentage was 87.

Of females of this age, none had a hæmoglobin percentage of 90 to 100; in 35 per cent. it was 80 to 90; in 55 per cent. 70 to 80; and in 10 per cent. below 70.

The average hæmoglobin percentage was 76.

The greater confinement of girls and young women indoors, which has been suggested as the cause of the more frequent occurrence among them, may partly account for it, but in those who are anæmic other influences are at work in predisposing to phthisis. Owing to the anæmia the absorption of the normal quantity of oxygen is impossible, and digestion is defective, with the result that the effect which fresh air and good food have in maintaining the health is rendered partially ineffective. Energy also is deficient, and the physical strength reduced, in consequence of which, when the work is over and open-air exercise might be taken, this is neglected, or taken in deficient amount.

The effect of menstruation, pregnancy, parturition, and lactation have been suggested as causes of the greater prevalence of phthisis among women under thirty-five years of age.

These are physiological processes, and when the individual is of sound physique they have no injurious effect; on the other hand, when the health of the body is defective owing to anæmia, they tend to increase the already lowered vitality of the tissues.

Normal menstruation indicates a healthy state and only slight temporary anæmia is occasioned by it, such that would in no way predispose to phthisis;

but when an anæmic condition is present, as long as menstrual function continues, it still further reduces the quality of the blood, which is not recovered from as in health, owing to the defective vitality of the blood-forming organs, and thus the predisposition to phthisis is increased.

During pregnancy sound blood is a necessity for the health both of the mother and of the embryo; and when an anæmic woman becomes pregnant, oxygen and nutrient material, which are present in the blood in deficient amount, are needed to a great extent for the growth and development of the fœtus, in consequence of which the vitality of the maternal tissues, including those of the blood-forming organs, is reduced, and thus the anæmia and the liability to phthisis already present are still further augmented.

Parturition, when any abnormal hæmorrhage occurs, still further reduces the quality of the blood, and I have frequently noticed that there is a greater tendency to post-partum hæmorrhage of various degrees in those who are anæmic; for this reason the predisposition may be aggravated by it.

Lactation during the first nine months of the infant's life has no ill-effect when the mother's health is sound; but when anæmia is present, the constant drain of material from the blood for the formation of milk still further reduces the vitality of the maternal tissues, including those of the blood-forming organs, and thus the anæmia and the tendency to phthisis are increased.

After thirty-five years, as Dr. Ogle's tables show, the rate of mortality from phthisis is higher in men; and although anæmia is still more prevalent among women, there are predisposing influences from which after this age women are to a great extent relieved, and others to which men are more exposed, which will largely account for the higher rate.

After forty years the child-bearing period is usually at an end, and thus women are relieved of those adverse influences on the health that pregnancy, parturition, and lactation have in those who are anæmic, and to which the greater prevalence among them before this age may be partly ascribed.

Dr. R. Thompson considers that the increased exposure of males accounts for their greater liability to acquired phthisis.[1]

This influence is one to which men are subjected in far larger numbers than women, and increasingly so after this age, on account of the fact that more women are employed in occupations other than those of a domestic nature, and which entail exposure, before thirty-five than after. Men are therefore more liable to acquire rheumatism, pulmonary diseases, and others which lower the vitality of the body and predispose to phthisis.

A larger number of men after this age are also employed in dusty occupations, and thus are more subjected to any tendency to phthisis that they may occasion.

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[1] Douglas Powell, 'Diseases of the Lungs,' fourth edition, p. 355.

The effect produced by some of the diseases which are precursors of phthisis points to its connection with anæmia.

The most obvious ways in which various diseases predispose is, on the one hand, by causing some local pathological lesion, whereby the entry of bacilli into the system is facilitated, and, on the other hand, by lowering the vitality of the tissues of the body as a whole. In this latter direction there can be no more frequent way in which they have a predisposing effect than in causing secondary anæmic conditions of the blood.

Measles, whooping-cough, and small-pox are commonly the precursors of phthisis. The predisposition caused by these diseases may be partly accounted for by the catarrhal inflammation set up in the tissues of the lungs by the pulmonary affections which are often complications of them. They also cause secondary anæmia, and, owing to the fact that the blood is already defective in quality in various degrees in a large proportion of those who acquire them, the vitality of the tissues is lowered to a greater extent than would have been the case had the blood been in a normal state before their onset.

Dr. Osler remarks that 'the gastric mode of onset is very common' in phthisis, and that 'in young girls and in children) with the dyspepsia there is very frequently a pronounced chloro-anæmia.'[1] Dr. F. Roberts says gastric ulcer and long-continued dyspepsia predispose.[2]

Tuberculous disease of the stomach is of rare occurrence; primary lesions of the intestines are also considered to be infrequent in adults, and although more prevalent among infants and children, taking those of all ages together, phthisis can only comparatively rarely be secondary to tubercle in these organs.

In the causation of chronic gastritis and gastric ulcer anæmia, as already described, plays a large part, and when they have developed they still further decrease the quality of the blood.

Syphilis, typhoid fever, and rheumatic fever are also diseases which cause secondary anæmia in various, and often severe degrees.

Although some of the pathological lesions set up by these diseases may favour the entry of the bacilli into the system, the predisposition to phthisis induced by them may be mainly attributed to the lowered vitality of the tissues, caused by the anæmic conditions of the blood with which they are associated.

The Prevention of Tuberculosis.

It is as important, if not more so, than is the case in any other disease, that tuberculosis, owing to its destructive effect on the tissues, should be prevented, and this is especially evident in regard to the lungs.

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[1] 'The Principles and Practice of Medicine,' sixth edition, p. 321.

[2] 'The Theory and Practice of Medicine,' tenth edition, vol. i., p. 367.

The delicate tissue of which they are composed is that most frequently attacked by tubercle, with the result that in many instances portions of the lung are rapidly destroyed, and once destroyed, they are incapable of being restored. Many of the pathological lesions caused by disease, after their arrest, entirely disappear during convalescence, leaving no traces behind, and occasioning no impairment of the functions of the tissues which were affected; but, as Dr. F. Taylor says, 'complete recovery of the lung from tubercle perhaps never occurs.'[1]

That it may often be arrested is well known to be the case, and those instances in which fibrous tissue is found in the lung after death from other diseases show that after the formation of tubercle a healing process has occurred; but in such cases some destruction of tissue has taken place, and so the oxygenating function of the lung has been impaired.

The prevention of phthisis is important, also, owing to the fact that its onset is often of a particularly insidious nature, and in many instances severe hæmoptysis is the first indication that the lung is affected. It may also have progressed to a considerable extent without causing distinct local physical signs, or they may be so slight that it is at first impossible to form a definite decision as to their being caused by tubercle.

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[1] 'The Practice of Medicine,' fifth edition, p. 468.

In this country the attention has been directed to the following precautions for the prevention of tuberculosis :

1. **TO PREVENTING THE DISSEMINATION OF THE TUBERCLE BACILLI.**—In Germany sanitary measures are extensively taken with this end in view, and the importance of such has been increasingly recognized in England in recent years ; but the great difficulty of effecting this object becomes evident when the prevalence of phthisis and the large numbers of bacilli which are voided in the sputum are taken into account.

2. **TO PREVENTING THE CONSUMPTION OF FOOD DERIVED FROM TUBERCULOUS ANIMALS.**—Although means to achieve this result are thought unnecessary by some observers, unless it can be definitely proved that human tuberculosis is not acquired by consuming infected milk and flesh, it appears to be the safest plan to continue to prohibit the sale of all food derived from those which are affected.

3. **TO IMPROVING THE HYGIENIC ENVIRONMENT.**—Steps taken with this object in view are generally admitted to be of great importance in the prevention of tuberculosis.

4. **TO MAINTAINING THE HEALTH.**—While the need of adopting the preceding measures may be fully recognized, in order that they may have the best effect it is of the greatest importance that each individual should be maintained in sound health, as far as this can be done by medicinal and other means.

It is generally considered that all individuals are exposed to the attack of the bacilli in districts where phthisis is prevalent; what, then, prevents their setting up tuberculous lesions in many? It must be that none of the tissues are predisposed, and that the bacilli are either destroyed or expelled from the body.

Anæmia, in consequence of the predisposition to which it gives rise, will, I believe, mainly account for the prevalence of tuberculosis, and that the maintenance of sound health, for which normal blood is essential, is the greatest safeguard against its development.

By restoring to, then, and maintaining the blood of men and women in a healthy state, such predisposition as is hereditary and congenital may be largely reduced.

Similarly, by restoring to, and maintaining the blood of infants, children, and those of all ages in a sound condition, in combination with such hygienic measures as are known to impede the dissemination of the bacilli and to be beneficial to health, tuberculosis may be to a great extent prevented.

CHAPTER XI.

PREVALENT DISEASES AND THE BLOOD—*Continued.*

Rickets.

THIS is a disease of infancy and early childhood in which the nutrition of the whole body is impaired.

It is mainly characterized by the effect produced in the bones, which become softened; there is also an enlargement of the ends of the long bones, and various other abnormal features may be present. The liver and the spleen are also often enlarged, and the muscular tissues become relaxed and wasted.

The affection is of common occurrence in the crowded areas of cities, but is also found among families who live under the most satisfactory hygienic conditions.

NORMAL BONE.—' Bone is composed of earthy and animal matter in the proportion of about 67 per cent. of the former to 33 per cent. of the latter. The earthy matter is composed chiefly of calcium phosphate, but besides this, there is a small quantity (about 11 of the 67 per cent.) of calcium carbonate, and calcium fluoride, and magnesium phosphate' (Kirke).[1]

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[1] 'Handbook of Physiology,' thirteenth edition, p. 58.

There are two kinds of tissue in bones, the compact and the cancellous, and on studying the minute anatomy its nutrition is seen to be fully provided for.

BONE IN RICKETS.—Gray says: 'Rickets depends upon some defect of nutrition by which bone becomes deprived of its normal proportion of earthy matter, while the animal matter is of unhealthy quality. In the vertebræ of a rickety subject, Bostock found in 100 parts 79·75 animal, and 20·25 earthy matter.'[1]

It is thus seen that, as only 11 per cent. of the 67 parts of earthy matter in normal bone are composed of substances other than calcium phosphate, a deficiency of this substance is one of the main defects in those which are rickety.

THE BLOOD.—Dr. Cabot observes: 'Anæmia is always present in severe cases and often in moderate ones. The hæmoglobin is always relatively low, it averaged 63 per cent. in Morse's cases, a colour-index of 0·7.'[2]

Causation.—It most frequently commences between the age of six months and two years, and sometimes under the half year. That an insufficiency of good air and of food, overcrowding, and inefficient ventilation, favour its development is generally accepted.

Dr. F. Taylor says, with reference to the fats and proteids of food: 'It does not seem improbable that a defective supply from the mother to the fœtus *in utero* might start the disease even before birth.'[1]

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[1] Gray's 'Anatomy, Descriptive and Surgical,' fifteenth edition, p. [30].

[2] 'Clinical Examination of the Blood,' fifth edition, p. 401.

Dr. Osler remarks: 'The better the condition of the mother during pregnancy, the less likelihood is there of the development of rickets in the child.'[2]

An unsuitable diet is especially considered to be productive of the disease, and one which contains a high percentage of starch, and consequently a deficiency of proteids and fats, or one containing substances such as are consumed by adults, is frequently provided.

The effect of a faulty diet in the causation of rickets is demonstrated by experiments on animals, as conducted by M. Guérin, who found that puppies which were fed on raw flesh for six months became rickety; also by observations of Mr. Bland-Sutton, who found the affection present in young lions which had been brought up on similar food, and that they were relieved of the disease by adopting a suitable diet and treatment.

Observers agree that rickets is not hereditary, but that, as Drs. Ashby and Wright say, it is more likely to occur in the children of weakly parents.

Any inherited predisposition may, I believe, be mainly attributed to the defective nutrition of the spermatozoa or of the ovum, owing to anæmia in either parent.

Rickets is only rarely congenital, but the predisposition may be commenced during intra-uterine life, when the nutrition derived from the maternal blood is deficient. The blood-tests show the large number of women who are anæmic, and, in consequence, neither capable of maintaining the normal nutrition of their own tissues, nor of supplying, during pregnancy, the nutritious material which is necessary for the efficient growth and development of the bones and other structures of the embryo.

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[1] 'The Practice of Medicine,' fifth edition, p. 899.

[2] 'The Principles and Practice of Medicine,' sixth edition, p. 430.

Although an improper diet on the part of the mother during pregnancy would, as Dr. Taylor suggests, have an effect in the production of rickets—such effect being brought about by its reducing the nutritious value in certain constituents of the maternal blood which should normally be present, and causing an excess in others—the fact remains that, however good, sufficient, and of suitable constituents the food may be, when anæmia is present the absorption of oxygen is deficient, and, owing to the defective state of the alimentary system, normal digestion and absorption are impossible.

That an inefficient supply of mother's milk has an influence in the causation of rickets is generally admitted.

As previously referred to, for the secretion of normal milk there must be a sound condition of the maternal blood, and consequently the infant of an anæmic mother, if breast-fed, is brought up on milk which is deficient in the material necessary for the nutriment of the bony and other tissues of the body.

The blood-forming organs of the infant at birth are also imperfect when nutrition during intra-uterine life has been defective, and they are unable to supply healthy red corpuscles, in consequence of which a reduced amount of oxygen is absorbed; in addition, the functions of the digestive organs are impaired, and thus the infant of an anæmic mother —whose blood is not restored—if reared on modified cow's milk, is incapable of its efficient digestion and absorption, and nutrition is still defectively maintained.

The production of rickets is slow, and in those in whom nutrition has been imperfectly maintained during fœtal life, and during the first nine months after birth—whether owing to the defective quality of the mother's milk, or to the incapability of digesting modified cow's milk—if not already present, will be precipitated by the substitution of a diet containing substances which, although suitable for those in sound health, would constitute a faulty diet in those whose vitality is low, and digestive power consequently weak.

Acquired anæmia in infants and young children will also prevent food, even of the best quality and of the most suitable constituents, from maintaining the normal nutrition of the bony and other structures of the body, and when the feeding is at fault, rickets is still more likely to develop. That the disease may be produced by a faulty diet, and unconnected primarily with anæmia, appears to be proved by experiments on animals. This can be accounted for by the blood being rendered deficient in certain constituents and plethoric in others; it then becomes incapable of maintaining the effective nutrition of the tissues, including those of the blood-forming organs. Thus a secondary anæmic condition occurs, and the defective diet then has the same effect as when primarily connected with anæmia.

The physiological necessities of nutrition as it occurs in the tissues generally show that a diet mainly composed of one constituent of food would fail to maintain their health, for, as an instance, muscle lives not on one constituent brought to it by the blood, but, as Sir M. Foster says, on 'the proteids, fats, carbohydrates, salts, and water of the food and on the oxygen of inspired air.'[1] So it is with bones and other structures: for their healthy state they require these elements, which in the embryo are derived from the maternal blood, and in the infant are best obtained from fresh air and a normal supply of mother's milk for the first nine months of life, and later from a suitable supply of food.

Defective ventilation and overcrowding, if not alone sufficient to induce rickets, would aggravate the other causes; but however good the atmospheric environment may be, unless the blood of the mother contains the proper amount of hæmoglobin, a deficient supply of oxygen will be available for the growth and development of the embryo ; and, similarly, after birth, unless the infant's blood is sound, the quantity of oxygen which is needed for its nutrition will be reduced.

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[1] 'Textbook of Physiology,' part ii., sixth edition, p. 862.

Thus the production of rickets may be mainly attributed to the association of anæmia with defective feeding.

A summary of its causation may be made under four heads :

1. Those in whom it develops on account of the predisposition caused by malnutrition during intra-uterine life, and whose blood is not restored after birth. Of such infants some are breast-fed, but in consequence of the deficient quality of the mother's milk, normal nutrition is not maintained ; others are brought up on modified cow's milk, but they are incapable of its effective digestion and absorption. In either case it may be precipitated by a change of diet after the ninth month.

2. Those in whom it occurs owing to the predisposition caused by defective nutrition in embryonic life, whose blood is not restored, and who are brought up by hand on a faulty diet.

3. Those in whom it is present as a result of acquired anæmia in infancy or in early childhood, and who are thus incapable of satisfactory digestion and absorption, although a suitable diet is provided. Such children may be supplied with an unsuitable diet, and the probability of rickets occurring in them is still greater.

4. Those in whom it is found in consequence of a faulty diet, although nutrition during intra-uterine life has been normal, and unconnected primarily with anæmia.

The acquirement of the disease from either of these causes may be still further induced by living under unfavourable hygienic circumstances, with regard to overcrowding and ventilation.

The prevalence of rickets may, I believe, be mainly accounted for by conditions such as occur under the first three heads, and especially under the first two, and that its occurrence under the fourth is less frequent than under any of the others.

As rickets is chiefly due to improper feeding in association with anæmia, so the provision of a suitable diet and the restoration of the blood are the measures chiefly necessary in its treatment.

One of the chief defects in the bones is a deficiency in calcium phosphate, but the result of treatment shows that, although cod-liver oil, which may be classified as a food principally composed of fatty constituents, is valuable, and has, as Dr. M. Bruce says, a hæmatinic action, iron is the drug which has the best effect in restoring the rachitic to health, and not, as might be supposed, a preparation containing calcium phosphate. Iron acts by restoring the blood, which then becomes capable of absorbing the proper amount of oxygen; the digestive organs are also restored to health, and the efficient digestion and absorption of food becomes possible. Thus, with the gradual renewal of the oxygen-carrying and nutritive capacity of the blood, the bony and other tissues of the body regain a more healthy state.

The Prevention of Rickets.

When rickets has developed it is, as a rule, capable of arrest by providing suitable treatment, diet, and satisfactory hygienic environment. The firmness and solidity of the bones returns, but characteristic defects produced by the disease, as stunted growth, deformities of the chest, pelvis, and bones of the extremities, often remain, and, in the case of the contracted pelvis in women, unfits them to become the mothers of well-developed infants. Owing to its prevalence, and the frequency of such serious results, the reduction of rickets is of great importance to a nation's physique.

Although anæmia in the father may have an effect in predisposing to rickets, and the restoration of the blood of men will thus aid in its prevention, any parental influence in its causation is mainly attributable to the mother.

By restoring to, then, and maintaining the blood of women in a sound condition, in combination with the provision of a suitable diet and healthy hygienic environment, such predisposition to rickets as is commenced during intra-uterine life may be largely prevented.

In a similar manner, by restoring to, and maintaining the blood of infants and young children in a normal state, in combination with the provision of a suitable diet and favourable hygienic surroundings, the occurrence of rickets may be lessened to a great extent.

CHAPTER XII.

CONCLUSION.

THE importance of individuals having normal blood in order that they may be in the best position to maintain health, and that sufficient energy may be supplied both to obtain full satisfaction from the work of life and for the enjoyment of either mental or physical relaxation, has now been considered.

A good physique and sound blood also give those who leave England to live in other countries or in various parts of the British Empire the best opportunity of maintaining health although the climate and environment may be less beneficial.

There is, also, the appearance of health in those who have lived with an efficient blood-supply, and instead of the pale face, ill-developed body, and relaxed condition of the tissues, the reverse is seen, and there is colour in the cheeks, a well-developed body, and a normal state of the muscular and other tissues.

The observation has been made that many of the population of the present generation, more especially the women of some classes, are taller than those of a past generation.

This may be the case, but if they have lived and developed with anæmic blood there is a lack of effective growth and development of the bony, muscular, and other tissues of the body, and although taller, their powers of mental and physical endurance are less than should normally be the case.

The opinion has been expressed that the deterioration which is seen is mainly confined to the poorer classes. Although those who belong to the upper and middle classes are in a better position to maintain a healthy physique, owing to the fact that they are, as a rule, better clothed, housed, fed, and that their hygienic environment is more satisfactory, observations show that anæmia and deteriorating influences are very prevalent among them.

This has been said to be a levelling age, and if there is one thing more likely than another to reduce a population by degrees to one level of inferior health, it must be that, although living under the most favourable conditions, owing to the prevalence of anæmia many individuals are neither mentally nor physically equipped with those qualities which otherwise with normal blood would be present.

Although personal observations as to the physique of the population have been made with respect to England and a part of Wales, the 'Report of the Committee on Physical Deterioration' indicates that influences adverse to health are affecting the inhabitants in all parts of Great Britain and Ireland.

Such observations, also, as are possible to make in London among the large numbers of those of foreign extraction, show that many Americans, Germans, French, Russians, and individuals of other nationalities have blood which is anæmic in various degrees.

There is additional evidence, from accounts in the medical journals and from other sources, that physical deterioration is not confined to the inhabitants of this country.

It was stated in the *British Medical Journal* (January 10, 1905) that a special Commission, appointed by the New York Health Board, reported, with regard to the children attending the public schools, 'that of 7,776 examined in April, 3,132 required some immediate medical attention if they were ever to become normal citizens; 1,275 were unable to distinguish the big letters of the ophthalmic test-card at a distance of 20 feet; 1,221 were found to be suffering from enlarged internal glands, 632 from bad nutrition, 733 from cardiac affections, 127 from pulmonary complaints, and 1,946 from toothache.'

In most of the European countries the infant mortality is high. With regard to Germany, the American Consul-General, in a report to his Government, said that of the total number of deaths in the year 1902, 34·5 per cent. were of children under one year of age.[1]

---

[1] *British Medical Journal*, July 1, 1905.

The excessive infant mortality in Queensland is also attracting increased attention.[1]

There is said to be a decrease in breast-feeding among the women in all highly civilized countries.[2]

Over-fatigue, also, as disclosed at the International Congress on Hygiene in Brussels, is becoming a question of increasing importance.[3]

These and other facts show that, whether or not physical deterioration is more apparent in England, in other countries influences are at work which tend to diminish the health and to retard the normal growth and development of many of their inhabitants.

In consequence of the part taken by the blood in the nutrition and life of the tissues, and of the deteriorating effect produced on it by disease, drugs which increase its quality by their hæmatinic action are more needed to restore and maintain the health of individuals than are those such as strychnine, which come under the head of nervine tonics; and it is probable that, as long as diseases exist which are capable of reducing the vitality of the blood, so long will iron take an important position among the drugs used in medical practice: for although the provision of good food, air, and satisfactory hygienic environment have an effect in restoring the blood of those who are anæmic, its restoration to a healthy state requires the administration of an inorganic preparation of iron.

---

[1] *British Medical Journal*, May 6, 1905.

[2] 'Report of the Committee on Physical Deterioration,' 1904, pp. 50, 51.

[3] *Ibid.*, p. 28.

The physical deterioration that is going on among the population of England may, I believe, be chiefly attributed to anæmia, but, owing to the inherited strength and development of the bony, muscular, and nervous structures of the body, the British race will no doubt show the capability of regaining any loss of physique, and this result may be mainly brought about by restoring to, and maintaining the individual's blood in a sound condition.

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